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WITH WHICH IS INCORPORATED

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The Editor's Review of the Industry in 1939

WRITING of the foundry industry in 1938, we said that in no country has it been really healthy, for where it has been showing gains, the improvement has been due in a large measure to armament orders. Reasoning along these lines, the foundry industry of the world must after four months of war indeed be really "sick." Yet this is by no means a true picture, for in America there has been a steady increase of business in practically all sections, marred only by a prolonged strike at the Chrysler plant involving some 80,000 workers. Such an interruption of industrial activity has wide repercussions. Canada, the industrial resources of which may prove to be a decisive factor in the war, possesses a well-balanced and thoroughly modern foundry industry, which has been maintained at such a high level of production that plant extensions are constantly in the news. The American trade Press is devoting special sections to recording its activities, well realising its importance as a market for American machinery. The neutral countries of Europe have in general placed their foundry industries on a war footing, that is to say they order the conduct of their foundries so that defence requirements take preference over all other types of business. Moreover, in several countries there are difficulties in obtaining raw materials. Belgium is probably the best placed of all to carry on its extensive foundry industry at a maximum production. That country, however, is not by any means free from industrial anxieties. There have been strikes in related industries, as, for example, mining, whilst there is a tendency for basic costs to rise more quickly than selling prices. In Germany, as far as can be gathered, the conditions are much the same as in this country, full pressure is exerted on the steel, malleable and grey-iron foundries attached to engineering works and machine-tool builders, and, of course, the non-ferrous and light alloy plants. To what extent they are hampered by a shortage of raw materials and transport difficulties is not revealed by the German press. It is known, however, that before the war there was a strict rationing in force, for all the principal raw materials. Even the amount of metal founders could use for runners and risers was controlled. Profit making is automatic, and on a generous scale for the best managed concerns, as its magnitude is a function of internal efficiency. The Polish foundry industry was subjecting itself to great expansion, until the double invasion; now, we should imagine, things are pretty quiet. We base this reasoning on the industrial activity of Belgium during the last war, which was at a particularly low ebb. The foundry industries of the two Dominions, South Africa and Australia, are showing increased activities. The former has in recent times placed very important orders—one embracing vitreous enamelling plant—with the United Kingdom foundry equipment firms. There is still a tendency in Australia to buy American plant, but the great progress being registered in the United Kingdom will in due course be recognised and appreciated in the southern hemisphere. An interesting repercussion of the war has been the receipt in this country of curious inquiries from out of the way places for complete foundries, presumably because deliveries of castings and machinery from the belligerents have been temporarily suspended. The requirements as expressed in these inquiries are often so badly balanced as to render the propositions definitely uneconomic under no matter what conditions.

United Kingdom Foundry Industry

It is somewhat difficult mentally to separate the first eight months of the year from the last four, and moreover the incidence of the war has been so profound in its repercussions that the striking of a balance, without recourse to figures, is almost impossible. The situation can best be summed up by the bald statement that the impact of war on the foundry industry has been as irregular as Latin verbs. As an industry it has had many common experiences. Several months before the outbreak of hostilities, the foundries found themselves committed to large capital expenditures for the provision of air-raid shelters. By June, the month of the International Foundry Congress, preparations were virtually complete. What effect this had on the visitors from Germany we can only surmise, but if they were honest in their reports, their notes must have made interesting reading for the military authorities.

No sooner had the A.R.P. works been completed when the lighting and anti-glare orders were imposed. Conjointly with the iron, steel and glass trades, the foundry industry was particularly badly hit by the necessity for obscuring the glare emitted from furnaces. The methods brought to our notice have often exhibited commendable ingenuity, but the problem is so complex that there is no standard panacea available. Generally speaking, taking the industry as a whole, the problems are well on the way to solution. There have been some very unfortunate repercussions arising out of the industrial black-out conditions. Ventilation has been impaired, and foundries which were noted for their tidiness find it somewhat difficult to maintain their former standards, as ill-lit shops are conducive to untidiness. Again, poor lighting is productive of accidents in the workshops as well as in the streets. Finally, the effect is depressing. The remedies suggested are increased "safety-measures" and the installation of a sound, well-organised welfare department.

The managements of the larger foundries, having satisfied themselves that they have fulfilled all the provisions associated with A.R.P. and lighting restrictions, next had to turn their attention to camouflage. This has in general been intelligently carried out, especially by those more recently treated, although some of the earlier efforts were too stereotyped.

It is apparent that the effect of the control and the necessary wartime impositions have created within the ironfounding industry an added community of interest and as a result there is greater evidence of a desire to co-operate. This has evidenced itself by the formation of the Ironfounders' National Committee. With the potentialities of this body, we dealt at some length last week. Mr. Harper in his review of last year's happenings in the grey-iron foundry industry confirms our view that such a body must be kept in being to steer the trade through the post-war upheavals. Almost contemporaneous with the declaration of war, Mr. Charles W. Bigg was appointed by the Minister of Supplies to control grey-iron castings. After four months, under his direction, the industry has nothing but praise for the way he has handled the situation. His major worry is the constant reiteration to his innumerable friends in the industry that he has nothing to do with the placing of orders. His business is to help founders to deliver their goods in the correct sequence.

The outstanding event of the year was the International Foundry Congress held in London in June. Its success was universally acclaimed, and it has firmly secured for the Institute of British Foundrymen recognition as occupying a high position amongst the professional associations of the country.

PRINCIPAL CONTENTS

	Page
Editor's Review of the Industry in 1939	19
Grey-Iron Foundry Industry: by Wilfred L. Harper	21
Malleable Cast Iron Industry: by G. R. Shotton	22
Steel Casting Industry: By Francis W. Lowe, M.Sc.	23
Foundry Pig-Iron Trade: by E. J. Fox	25
Refractory Materials in 1939: by Frank Scott Russell	26
Vitreous Enamelling Industry: by B. B. Kent	26
Institute of British Foundrymen: by W. B. Lake, J.P.	27
Foundry Research in 1939: by J. G. Pearce, M.Sc., F.Inst.P., M.I.E.E., M.I.Mech.E.	29
Technical Development During the War	30
High-Duty Cast Iron: by A. B. Everest, Ph.D.	31
Foundry Equipment during 1939: by G. E. France	33
Rising Metal Prices: by "Onlooker"	33
Non-Ferrous Metals in 1939: by Our Metal Exchange Correspondent	34
News Highlights of 1939	36
How American Foundries Fared Last Year: by Oliver Smalley, O.B.E.	38
Poland's Foundry Industry in 1939: by Adam Harasowski	39
Latest Foundry of the Midland Electric Manufacturing Co., Ltd.: by Vincent C. Faulkner, F.R.S.A.	41
Book Review	45
Principles of Foundry Management: by A. J. Shore	45
Types of High-Duty Cast Irons: by A. J. Nicol Smith, B.Sc., A.I.Mech.E.	51
The Week's News in Brief	54
Trade Talk	54
Personal	54
Obituary	54
Reports and Dividends	54
Raw Material Markets	55

Light Castings

Last year began badly for most sections of the trade, but as the months passed by there was a distinct pick-up. In any case it maintained the promise of being better than 1938, which in the earlier months of that year was distinctly poor. By August, work was reasonably plentiful, though the shadow of the war had prevented much forward buying. As soon as war was declared there was almost a complete cessation of building. This would have been a natural consequence, but it was reinforced by Government edict. There only remained the export trade; a modicum of Government work and extensions to works engaged on munitions. Actually in some areas despite an absence of house building, the work created by shop extension kept the building contractors reasonably employed. The gigantic evacuation caused a certain amount of buying of new heating and cooking apparatus, until a somewhat premature order threatened to ration the consumption of coal, gas and electricity. A few weeks later the conditions appertaining to gas and electricity were relaxed, but not so with coal, which measure adversely affected the makers of solid-fuel burning apparatus. Somewhat belatedly, this order too was withdrawn. Of all the branches of the light castings industry, the section which has been most adversely affected is that devoted to the manufacture of baths. Moreover, it happens to be the trade which has in normal times to meet, both in the home and export markets, the full blast of foreign competition. We are unaware of the state of the building trades in the overseas markets, but we see no reason for their relapsing into non-existence. The British blockade will effectually prevent German baths reaching these markets. Finally, there is no shortage of high phosphorus iron in Great Britain. The new President of the Board of Trade, Sir Andrew Duncan knows all about the iron and steel industry and he would surely lend his great influence to a properly prepared proposition of a Government subsidy to build up stocks for export the minute shipping tonnage becomes available. To our mind, it is better to pay such a subsidy than to have highly skilled men working two days a week or drawing upon the funds of their union and the unemployment insurance benefits. Export statistics ceased with the August figures, and no useful purpose would be served by analysing the first eight months of the year, as they would provide no pointer as to future trends and activity.

Steel Founding

Never in the history of this branch of foundry practice has such activity been experienced. Orders are there, not so much for the asking, as for the ability to execute them. The number of steel foundries is less than during the last war, but the aggregate capacity is greater and is being increased. Quite a number went out of business during the post-war slump, Spencers, of Newburn, being the most important. Extensions to steel foundries are coming to our notice, but in the national interests, their location cannot be given. There have been several new foundries put into commission during the last two years, and the outputs, both as regards quality and quantity, are most encouraging. One of them in particular is extremely successful in the admittedly difficult task of casting aerial bombs, the tolerances on which are almost unbelievably strict. The steel foundry industry at long last is well organised and there is a general appreciation of the work of the General Steel Castings Association. Speaking of trade associations in general, one encounters here and there a divergence of policy between the honorary and paid officials. The former seem anxious that their associations should be well known and respected, whilst the latter are often inclined to doubt the wisdom of printing even telephone numbers! As, in general, their activities have Government acquiescence, if not its blessing, the former policy seems to commend itself.

Malleable Cast Iron

What a different picture, this section of the industry presents compared with 1914. Since that time the trade has expanded out of all recognition by the creation of Crane's Foundry, at Ipswich, the Britannia Iron & Steel Works, at Bedford, Fords at Dagenham, coupled with the great extensions which have taken place at Leys, Hales, Shottons and Bagshawes, to cite but four. The rotary pulverised fuel or oil-fired furnaces have been installed in many malleable plants which at the least simplifies the anti-glare measures, whilst inducing much easier control. This control for certain sections of munition manufacture cannot be too refined. We are aware of metallurgical difficulties which exist and which call for co-operation in their solution. It is some satisfaction to note that this nation is not alone in this particular problem, but it is nearer to solution than most. During the year, it has suffered through the changing nature of its output. The motor vehicle industry was, as usual, irregular in its requirements, whilst when war came, the demand for private cars, except for export, was very meagre. Technically, the industry progresses satisfactorily, but we should like to see the quick anneal process exploited to a greater extent. Gillett says the summation of its mechanical properties is greater than the standard material, and what Gillett says is generally worth due consideration. The question of continuous annealing must receive more attention by the industry as the batch method now exploited is wasteful alike of both fuel and labour. Closer co-operation amongst the employers is obvious.

Agricultural Implements

Perhaps, in the long run it was not such a bad thing that the slumps of 1920 and 1929 caused the shutting down of a number of old-established concerns. It has left the industry virile and enterprising. Outstanding is the case of R. & A. Lister, where the efforts continuously made during the last twenty years have placed the firm in such a position that its products reach every quarter of the globe. Side by side with sales enterprise, there has been a progressive policy of plant extension and horizontal trustification. Following the last war, there was a marked tendency by American agricultural implement manufacturers to create branch establishments in Europe. Last time France was the usual choice, but just before this war there was a strong rumour of a large plant to be put down in the East Midlands by one of the largest American concerns. We hope that this will later be consummated, followed by others, as the industry still needs reinforcement for export.

High-Duty Iron Foundries

Those firms entirely specialising or having a specialised department for the production of high-duty cast iron are reaping the benefit of their earlier enterprise. Mr. Robert C. Stanley last year, in his masterly review of the nickel industry, stated that 10 per cent. of America's production of iron castings was alloyed. We are unaware of the corresponding British figure, but it is of an ever-increasing order of importance. Designers are finding that they can with advantage use some of the high-duty irons economically and rapidly to replace steel castings and forgings. Orders for this type of material are increasing, and the booking of such contracts often appears to be attractive to foundries which have hitherto had little or no experience of such material. Yet unless they are prepared to learn and apply the fundamental technique of its production they will fail either to give satisfaction to their customers or balance their books. It is quite possible or even probable that new melting plant, fresh sources of sand, and modified moulding technique, will be required before final success is achieved. Yet we strongly counsel that these steps be taken, because the knowledge so acquired will favourably react upon the general production and conduct of the foundry.

Machine Tools

Because for several years the foundries making machine-tool castings have been working to capacity, they are beginning to be regarded in certain quarters as profiteers. It is as well to remember that since the last war, which resulted in a surplus of machine tools, encumbering the secondhand market, the industry went through a slump of a very far-reaching character, and for years both masters and men suffered severe losses. It is not illogical to assume that they will need large financial reserves to meet the competition of "used" tools sold on behalf of the post-war disposal board. The courage, foresight and energy shown by most of the larger manufacturers of machine tools during the last decade is proving a great national asset to-day. The technical progress of these foundries has effectively placed the United Kingdom well in the forefront of European developments and established the goodwill of British machine tools in the overseas markets. Critics of their prosperity should bear these facts in mind.

Non-Ferrous and Light Alloys

For many months information about this section of the foundry has, especially where it contacts with aviation, been very guarded, and rightly so. "The Times Trade and Engineering Supplement" has some very interesting information on German aircraft industry. It is scheduled to produce by the spring some 30,000 machines. To effect such a production it requires a direct labour force of 170,000, supplemented by a further 280,000 working in ancilliary trades. Startling as are these figures, yet it seems that properly to maintain but 10,000 aeroplanes in wartime requires no fewer than 1.2 to 1.5 millions of workers. If these figures be correct, then it is logical to conclude that the Reich cannot, without endangering all other essential services, turn 4,000,000 men on to aircraft maintenance. We have taken no steps to evaluate activity in our own non-ferrous industry, but we cannot help but be aware of its amazing proportions. The astronomic expenditure announced by the Minister of Supplies—over £200,000,000 in four months—is sufficient guarantee that the non-ferrous foundries are kept busy.

The Future

Knowing full well that the fighting services will see to it that their own requirements are satisfied, we feel that it is our duty to focus attention on exports. Some firms are now finding it quite easy to fill up their books with home orders, but that is insufficient. Efforts should be made to secure orders for export as by this means credits are secured for paying for raw material and food imports. Moreover, after the war, despite the pious hopes of a re-arranged world economy, there will be the usual scramble for business in the international markets. Presuming, however, that some system of international cartelisation does result, even then the possession of an important share of a market is the major factor in future allocations. It should be remembered that with the buying capacity of the employees having been increased by £33,000,000 per annum since the war started, there is likely to be a demand for capital goods, which manufacturers may be tempted to supply instead of entering the export market.

Finally, a busy time is in prospect for the whole of the foundry trade except that section specialising on builders' castings.

The Grey-Iron Foundry Industry

By WILFRED H. HARPER (Director, John Harper & Co., Ltd.)

TO contribute a review of this nature in normal times is a comparatively straightforward task, which would deal in turn with the various sections of the grey-iron foundry industry, comment on new developments of the past year, and, finally, make a forecast of trade conditions for the coming year.

To-day, however, times are far from normal. It is difficult enough to carry on a day at a time, let alone look ahead into the future. There are already many new words and phrases in the industry, such as "Black-Out," "Priority Certificate," and "Anti-Glare Devices," etc., which a few months ago would have conveyed nothing, yet to-day represent conditions which vitally concern the industry.

Despite the feeling of growing tension and of insecurity, on account of the uncertainty of international affairs caused by a series of crises, the grey-iron foundry industry was reasonably busy at the beginning of 1939, and was kept fairly well occupied right up to the outbreak of hostilities. In the weeks immediately following the outbreak of war, the industry found itself in rather a precarious position. This particularly applied to those specialised foundries which had been planned, built and equipped for producing such castings as baths, domestic cookers, and fire grates, which, with the virtual cessation of the building trade, were brought almost to a standstill.

Desperate efforts were made to secure contracts for the few types of armaments made of grey iron, and many advertisements appeared in the daily Press offering to supply grey-iron castings from a few ounces up to 10 tons. After the first few weeks, however, many engineering firms obtained indirect contracts for war work, which called for cast iron, and the jobbing foundries gradually became busy again, although many of the highly specialised foundries are still very short of orders. This is reflected by the slow diminution of the heavy stocks of foundry pig for all grades except low phosphorus iron.

Ministry of Supply's Expenditure

Dislocation of industry is bound to take place when a country is at war. Taken as a whole, the grey-iron industry is to be congratulated in not being hit so badly and being disorganised, as is the case of such industries as retail distribution. After four months of war, the transition from peacetime trade to wartime demands has come about with far less confusion than one would have expected. To a certain extent this was due to the huge orders placed by the Ministry of Supply during the first months of the war for over £183,000,000, of which sum £45,000,000 was on transport vehicles, £12,000,000 on machine tools, £12,000,000 on scientific instruments, which brought orders for iron castings to many foundries.

The concerns which specialised in alloy cast iron, however, were more fortunate and have to some extent shared the rapid growth of the machine-tool trade. Also, owing to the fact that the malleable and steel foundries were working at full capacity, coupled with the fact that it became somewhat difficult to obtain aluminium for ordinary purposes, castings previously made in these materials have been successfully substituted by special high duty irons.

High Duty Irons

One of the high duty irons, which is now well established as an engineering material, is Meehanite Metal. It is now generally recognised that this cupola-melted metal is cast into camshafts and crankshafts and to-day, owing to the steel shortage, it is finding increasing application in entirely new fields of work, such as shipbuilding, cast to form dies for deep-draw metal work and light castings previously made in malleable iron. The Meehanite Research Meeting was held at Birmingham in June, under the chairmanship of Mr. Oliver Smalley. The meeting was attended by representatives from U.S.A., France, Italy, Belgium, and Scandinavia.

Increasing Costs

The industry soon found that altogether apart from the increased taxation and advanced cost of raw materials, extra costs were piling up. One cause was the increasing expense of lighting the interior of a blacked-out foundry and, on the other hand, the long-term effect of lack of daylight in impaired health, accident and defective castings. It is perhaps too early to form any definite opinion, but many foundries which entirely blacked out at the outbreak of hostilities, find that the increased cost of lighting, together with the general fall of efficiency figures, makes them consider even the extra expense of having shutters which will permit daylight during working hours.

MR. WILFRED H. HARPER

When one remembers the vicious circle which was created in the last war by uncontrolled wage and selling price increases, and the disastrous results which followed, there can be no doubt that the Ministry of Supply have performed a real national service in strictly controlling the selling price of castings, and it is of the utmost importance throughout the war that wage and selling price increases should not on any account be allowed to rise over and above the increased cost of living.

Another result of the war is the formation of the Ironfounders' National Committee, and it is to be hoped that this body, which is representative of the whole of the industry, will not merely be a wartime organisation, but will continue to function in peacetime, as an organisation of this kind has always been wanted.

Foundry Equipment Developments

With the exception of the "Sandontap" moulding system, which appears to have very great possibilities, there have been no outstanding technical developments during the past year. The Randupson process of using cement bonded silica sand blocks for the manufacture of large castings continues to make progress.

Many of the moulding machines in this country were imported from Germany or U.S.A., but to-day the industry is fortunate in having some first-class machines made in this country, originally due to the foresight of some of the British representatives of foreign machines.

Another new development which had a small beginning, and yet is having an effect on the industry as a whole, is the fact that it is now possible for a small foundry to purchase moulding plant on hire purchase terms. This new development, together with the free technical service now given by many foundry supply firms, has undoubtedly contributed to the very rapid growth of many of the small foundries.

Such trades as typewriter, refrigerator and automobile accessories, which in the past have benefited from Government protection and are now able to rely more on their own selling points and less on tariff protection, are now finding that owing to the restrictions on imports, they will have a clear field and even under wartime conditions expect to become increasingly busy.

Greater Welfare Effort Needed

In the past, the foundry industry in this country has on many occasions been accused of being guilty of working under deplorable conditions, which compared very unfavourably with those of the average foundry in the United States. In recent years, however, the industry has become more "welfare conscious" and the Factories Act, which became law last year, has improved matters in this respect.

During the past few months, welfare has perhaps been pushed into the background owing to the enormous demands of A.R.P. organisation. Nevertheless, foundry executives would do well to keep the welfare of the moulders well to the front. Moulders, who are "moulders" in the real sense of the word, are very few and far between and are to-day a definite national asset. The black-out restrictions have brought about increased strain in transportation to and from work and also in the foundry itself. Anything which can be done to improve the working conditions of the moulder will to-day be appreciated. One so often notices that some of the people who complain most bitterly about the difficulty in obtaining good moulders are those who give little or no attention regarding welfare.

The Future

To give one's views on the prospects of the future is at all times a precarious business, but event to attempt to forecast on 1940, with all the uncertainties of a wartime existence, is indeed impossible. One can only say that, providing sufficient supplies of raw materials are available—and no country is more self-sufficient—the grey-iron foundry industry as a whole will need all its energy to carry on, and all

(*Concluded on page* 24.)

The Malleable Cast Iron Industry

By G. R. SHOTTON (Works Manager, Shotton Bros., Ltd.)

A GENERAL slackening in trade became apparent at the close of 1938 and persisted during the first few months of 1939. The demand for malleable castings was very "patchy" until about April of the latter year, and there was considerable variation in trading conditions in different foundries. Some foundries maintained a normal flow of output while others were comparatively slack, and there was a noticeable tendency for selling prices to fall. The demand for malleable castings showed an improvement in the early spring and most foundries were working to capacity throughout the summer months.

The outbreak of war resulted in a wholesale cancellation of orders for certain industries, notably the motor-vehicle industry, but this was balanced by increased demands in other directions. The change-over was effected with remarkable smoothness, and few foundries experienced even a temporary drop in output. Malleable foundries are now working at high pressure and are experiencing some difficulty in meeting the heavy demands made upon them.

The malleable industry is perhaps unique in this country, in that there are a great number of small foundries, mainly operating on specialised classes of castings, compared with the small number of bigger producers. Under normal trading conditions there is no disadvantage attaching to this disproportionate distribution of manufacturing facilities, since most of the small producers normally handle only those classes of castings for which they are suited, and which often require only a modicum of technical control. Some apprehension may be felt, however, due to the tendency which has become noticeable during recent months for orders to be accepted by foundries that are not always suited for the production of certain types of castings.

In view of the very rapid improvement in the quality of malleable castings during the last few years, and the consequent bias towards the use of malleable cast iron on the part of many consumers who previously had used other materials, it would be a deplorable development if failures should be experienced in castings produced under unsuitable conditions. It might conceivably take several years to regain the confidence of engineers and designers who had been unfortunate in their experiences with malleable castings produced under such conditions.

The production of malleable castings is a highly specialised industry and has problems, both practical and metallurgical, which are quite different from those experienced in other branches of the foundry industry. Light-hearted attempts by small grey-iron foundries to make malleable castings as a "side line" are to be discouraged, since one or two such attempts have met with very doubtful success. Without suitable melting and annealing equipment, and properly trained and experienced personnel, such attempts can only result in financial loss to the foundry concerned and in a loss of prestige to the industry generally.

Raw Materials and Labour

Up to the moment there has been little difficulty in obtaining the necessary raw materials, and it is to be hoped that the control now exercised by the Ministry of Supply will ensure a continuance of these conditions.

Suitable skilled labour is not easily procurable for the increase in output now demanded of the industry, and this factor is likely to remain a major problem in the malleable industry. The labour shortage has been further accentuated by the withdrawal of many skilled workers on the Army Reserve, and there appears to be little prospect of securing the release of these men. In common with other branches of the foundry industry, malleable foundries also find difficulty in obtaining suitable boys who can be trained as moulders to provide for the future requirements of the industry.

Technical Progress

The year 1939 has not produced any outstanding development on the technical side of the industry, but there has been continual progress made in improving the physical properties of the material produced. But for the outbreak of war, it is very probable that the B.S. Specifications would have been revised in the very near future. The physical properties of black-heart malleable are maintained by many producers at a level considerably higher than the present specification, and the B.S.I. requirements would, in all probability, have been raised.

MR. G. R. SHOTTON

Both the Institute of British Foundrymen and the British Cast Iron Research Association, through their Malleable Sub-Committees, have done a considerable amount of work in obtaining and collecting data apertaining to specifications. The work of these committees was approaching completion, and, but for the dislocation involved by the outbreak of war, they would soon have been in a position to make definite recommendations to the B.S.I. Committee.

The use of the rotary furnace tends to increase, particularly amongst the smaller producers, with whom it is displacing the cupola as a melting medium. On the other hand, those plants operating either the air furnace, open-hearth furnace or electric furnace do not appear likely to change their melting methods.

Constant improvement in annealing technique is being made, and during the past year several foundries have installed new plant giving more accurate control of the annealing cycle.

The application of the short-cycle anneal has not shown much further progress, and does not appear likely to be adopted for bulk production in the near future. The consistently high quality of malleable castings now produced by several organisations calls for a fairly wide safety margin in both melting and annealing practice. For the production of short-anneal malleable a very exact balance is essential between the metal analysis and the annealing cycle, and while it certainly is practicable, it is too liable to variation in physical properties to make the process attractive for general application.

A great improvement in the finish of malleable castings is also apparent, and this may be largely attributed to the extensive use of the modern airless types of shot-blasting equipment.

It is very pleasing to be able to record the rapidly increasing co-operation between the designer and the foundryman. The practical difficulties of the malleable-iron founder are being appreciated far more fully, and designers generally are showing willingness to co-operate with the foundryman to obtain the most practicable and serviceable designs.

Future Prospects for the Industry

There seems every likelihood of the present heavy demand for malleable castings continuing throughout 1940. The motor-vehicle industry (particularly the commercial vehicle branch), service departments, shipbuilding and agricultural industries are likely to continue to consume large tonnages of malleable, and the electrical industry and general engineering trades should continue to take their full share of malleable castings. There seems every reason to expect that the light castings side of the industry will also be fully occupied during the coming year.

Prices are at an extremely competitive level, possibly due to the slackening in trade in the latter months of 1938 and the first three months of 1939. The restraint imposed on selling prices by the Ministry of Supply is likely to become a serious factor, as the rising costs of raw materials and increased wage rates are not being recovered in sales prices. In this respect the lack of co-operation amongst the malleable foundries in the past makes it impossible adequately to present to the responsible authorities a true picture of the industry's difficulties. Some relaxation of price control will ultimately become necessary if the industry is to be in a position to continue with the extensive improvement to manufacturing plant which has been the keynote of policy during the last few years.

A Cupola Hint

Mr. H. H. Shepherd, President of the East Anglian Section of the Institute of British Foundrymen, gives the following useful tip in his monthly letter to members of the Section: "Have you increased the amount of limestone to your cupola charges recently? Foundry scrap which might be lying in the yard picks up more dirt, and sand-cast pig-iron retains its sand more easily, and probably picks up some dirt, in wet weather, and members who may be experiencing trouble with dirty tuyeres or too thick a slag may not have thought of increasing the limestone a little to take care of this."

The Steel Casting Industry

By FRANCIS W. ROWE, M.Sc. (Manager, Penistone Branch of David Brown & Sons (Hudd.), Ltd.)

WITHOUT disclosing information which would be of value to the enemy, it is difficult to give a comprehensive survey of the trends in the steel foundry industry in 1939. This much can, however, be said in that the year has shown probably more progress, both technically and otherwise, than any single year since the last war.

Steel founding in Great Britain has had many difficulties and vicissitudes to contend with during the last twenty years, and there has been much to militate against the rapid progress and extreme technical efficiency associated with certain other specialised branches of the founding industry.

Long years of poor and mediocre trade had up to recent years drained many of the steel foundries of much of their vitality, and much plant in the industry was obsolete or obsolescent. Faith in the future was not sufficiently strong to warrant the sinking of fresh capital in many foundries. Similar conditions prevailed throughout much of the steelmaking trade, but the introduction of tariffs in 1936 gave the steel trade the measure of confidence to warrant an energetic policy of plant renewal and improvements. Steel founding had, up to the introduction of these duties, been subject to much Continental competition with which it was virtually impossible to compete, competition which arose from either a much lower standard of living in those European countries or from government subsidies. It should not be disguised also that the standard of technical efficiency in some of those countries was good—probably better than our own average at that time—and this was the natural sequence of better internal organisation within the steel founding industry in those countries and a protected home market for their products.

Benefits from Tariffs

The fillip given to the steelfounders of this country by the imposition of a duty on castings of foreign origin, except those intended for shipbuilding, came none too soon for the health of the industry, but its effects were soon noticeable, not so much in improved trading results as in plant improvements. Internal organisation within the industry soon followed, and as soon as internecine price cutting was removed a gradual but noticeable improvement in quality took place. Where service and quality are the only customer-appeal that can be made, the accent on these is soon apparent.

Steel founding in this country is limited to a comparatively few foundries, probably not more than 60. This is due to the much higher capital cost involved in steel founding on modern lines, and the higher minimum tonnage required to support both personnel and plant than in other branches of founding.

In these days of specialisation also the range of work undertaken by the jobbing founder is naturally lessening, and the scope for the "pin to white elephant" type of foundry narrowed. The technical requirements of each particular type of casting are becoming more definite, and thus the number of drawings and inquiries which merely call for "cast steel" are lessening every year. This in itself tends to specialisation and work of similar character, and specification tends to be diverted to a limited number of foundries, which is all to the good of the engineering industry in general and the steel foundry industry in particular.

The large majority of steel castings made are supplied to the trade as such, *i.e.*, there are but few engineering firms who have a sufficient consumption of steel castings within their organisation to warrant the installation of a steel foundry to cover purely their own needs, particularly if their requirements are at all varied in size and type.

The rise in demand for steel castings produced in this country and the more confident feeling which has been apparent in the trade over the last two or three years, have, as mentioned previously, led to both the installation of new plant to expand capacity and the replacement of old plant. It is interesting therefore to review the trends which have been taken in the type of new plant purchased. Amongst this there have been many new melting plants installed in the last two years, and nearly all of these have been electric furnaces of some type or other.

MR. FRANCIS W. ROWE

Electric Furnace Practice

The continuance of the electric furnace as a popular unit for steel melting for foundry work is due to several basic causes. Probably the most important of these is the relative price of electricity compared with other fuels for melting. There has been an almost continuous relative fall in the price of electricity for melting over the last twenty years. Much of this is due to the veritable triumphs of the electrical engineer in producing generating plant of greater efficiency. A modern generating plant will produce 70 per cent. more electricity for 1 lb. of coal than one installed twenty years ago, and whatever may be the drawbacks of the grid scheme, it can be confidently said that it affords the opportunity for the electricity generating industry to provide large quantities of current at the minimum price. Although much could still be said about the price charged for electricity in various localities and by various companies, there is no doubt that pressure of public opinion and the needs of the industry will eventually rectify many of the existing anomalies.

Another factor which has contributed to the choice of electric furnaces as melting units for new plant installed has been the relative higher increases in price for hematite pig-irons. Dictated no doubt as they have been by quite just and fair economic reasons, there is no doubt that they have placed those melting units dependent wholly or largely on hematite pig-iron at a disadvantage and rendered those types of melting processes less attractive than formerly was the case. To some extent also the choice has been influenced by the ever-increasing quality demand in the industry.

There is no tendency for the amount of allowable sulphur and phosphorus content in steel castings to increase; in fact, rather the reverse, and this has placed more emphasis on melting processes which can most easily and cheaply meet the demands for steel of high quality with low sulphur and phosphorus content.

New Large Units

Amongst units recently installed for melting there should be mentioned electric arc furnaces of 15 and 20 tons capacity which incorporate many features novel to the design of furnaces in this country. For many types of raw materials, the sliding or swing-aside roof presents considerable advantages in eliminating the major portion of the time usually occupied in charging an electric furnace, and thus leads to a superior time cycle per heat and greater thermal efficiency. Although not many, if any, electric furnaces have been installed in this country with rotating hearths for melting for steel foundry purposes, there is no doubt that this type of design presents many advantages both in thermal efficiency, reduced time cycle, and quality of steel produced. Whilst such a design increases the difficulties of construction and raises appreciably the initial capital cost of such a furnace, it is felt that more will be heard of this in the future.

High Frequency Furnaces

Apart from electric arc furnaces, there have been several installations in the last two or three years of high frequency furnaces for steel melting for foundry work. Although the high frequency furnace has an extremely high capital cost per ton of capacity and apparently also a much higher capital cost than economic considerations would seem to warrant, it has certain advantages where extreme flexibility is desired. There is no doubt also that had it not been for the inordinately high capital cost it would have risen to a greater degree of popularity for steel foundry work. Neglecting what, of course, cannot be neglected in working practice—the high depreciation charges of such a unit—the other working costs bear very favourable comparison with those of an electric arc furnace, chiefly, of course, because there are no electrode costs, which form an appreciable proportion of the working costs of an arc furnace. Although refining in the high frequency furnace is possible, it is not usually considered practicable, and therefore the sulphur and phosphorus content of the charge has to be regulated to suit that required in the resultant casting, which necessitates in most instances the use of high quality scrap.

This method of steelmaking is, however, comparatively foolproof and gives a liquid steel of any temperature that is desired, free from serious gas inclusions and freer from included slag than probably any steelmaking process except the basic electric arc furnace. As the plants are usually installed, *i.e.*, with one motor generator set supplying current to bodies of varying size, the fast production of small heats of special steel can be accomplished with the minimum trouble and maximum efficiency. It is often a great trouble in steel foundries catering for steels of varying analysis to accumulate sufficient moulds to warrant a special heat being put through any of the other types of furnaces, but such difficulties do not arise where a high frequency melting unit is installed. Where the type of work being done in the foundry calls for small quantities of liquid steel at frequent intervals, again the high frequency furnace presents many advantages.

Heat-Treatment

Several new and improved features are noted in the many heat-treatment furnaces which have been installed for handling steel castings in the last year or two. Great strides have been made in recent years by the gas industry and in many industrial centres the ability of the gas companies to secure large quantities of blast-furnace gas to mix with their coal-produced gas has resulted in industrial gas being available at prices which have rendered its larger use possible and economical.

The technical requirements of annealing or heat-treating furnaces for steel castings have risen enormously during the last few years, and the requirements in physical properties in the majority of steel castings are now such that none but furnaces having adequate temperature control and even heating in various portions of the furnace is sufficient to give structures which will meet the needs. This has rendered many of the old simple coal and coke fired furnaces inadequate, and many of the new furnaces installed have heating characteristics comparable in every way with those employed for the heat-treatment of most important engineering components. Several continuous hearth gas fired furnaces, both recuperative and non-recuperative, have been installed, particularly for smaller work, and the same factor of lower comparative price of electricity which has influenced the choice of electric furnaces for melting has also resulted in several electrically heated furnaces for heat-treatment and annealing being installed. The electric furnace for heat-treatment and annealing of steel castings presents many advantages which are not probably at first apparent when the subject is superficially examined. Most steel foundries purchase their current on a two-part tariff, and an annealing furnace is a most desirable addition to the load where a two-part tariff is in operation. Properly designed, it has a unity power factor, and since it is an easy matter to operate such furnaces on a 168-hour week, it contributes in no small measure to raising of the load factor, and therefore to the lowering of the average price of current used throughout the works. If the subject be gone into thoroughly, it will generally be found that the real cost of electric current as used in an annealing furnace is much lower than the average price paid.

With a comparatively simple design of batch type bogie hearth furnace with interchangeable bogies it will be found that the normal annealing cycle for steel castings can be followed for as low as 250 units per ton of steel handled, and on fuel cost alone this does not compare unfavourably with a modern town's gas fired furnace. Labour costs are, of course, lower than with any other type of furnace, and time and temperature controls are rather simpler and rather more certain, and the controls can be arranged so that a furnace can follow any predetermined cycle of time and temperature without any attention whatsoever during the cycle.

Shot Blasting

Amongst other new plant installed, the rise in popularity of shot blasting without the use of compressed air is noteworthy. In many foundries the very high cost of compressed air for shot blasting is perhaps not sufficiently appreciated, and the airless blast plant, in addition to eliminating this cost, usually works very much faster and as efficiently as a manually operated cabinet. There are certain difficulties of design, particularly as regards hollow castings, which have yet to be completely satisfactorily overcome. These difficulties are such at the moment that for work of certain types most foundries have found it necessary to retain one or more of their normal type of shot blast cabinet. Most foundries are finding that they can very usefully employ on an appreciable proportion of their work an airless shot blast equipment of the type indicated.

In actual moulding and core making methods the chief advances noted in the last year have been in the gradual extension of the use of silica sand bonded with colloidal clays for green sand work. This type of sand is generally entrenched in the steel foundry industry, particularly for such work as is normally considered to be suitable for green sand, and the range of work which is handled by such methods is being gradually increased.

Sand Control

Of the many technical improvements which are always being instituted, amongst the most noteworthy is the increasing attention which is being paid to sand control in the foundry to secure greater standardisation of mould conditions than has previously obtained in the past. One of the greatest complaints of the engineer regarding steel castings is the liability to variation in castings which always seems likely to occur, and elimination of this undesirable feature is of paramount importance to the industry. It can obviously be only secured by greater standardisation of working conditions throughout, and in no small measure will rigid standardisation of sand conditions both for moulds and cores contribute to this end.

In steelmaking procedure, the attention which has been focused on the question of grain size in steel for heat-treated forgings is also being given to steel for castings. Grain size is to a large extent associated with deoxidation procedure and the correct use of aluminium additions at the right time and in the right quantity has been found not only to give a steel of controlled grain size, but also to eliminate an undesirable type of non-metallic inclusion formation which may be present in steel otherwise apparently correctly made. Manganese sulphide inclusions in chain formation materially lower the impact strength of cast steel, and since impact strengths are being considered an important feature, careful attention should be given where rigid specifications are to be met.

Increasing attention is being paid to the X-ray examination of castings by X- and gamma-rays, and at least one other steelfounder has installed a powerful X-ray plant during the last year.

Alloy steels are becoming more importantly used, and this general tendency of engineers to appreciate the value of alloy steel castings will undoubtedly lead to more technical equipment of various kinds to deal with alloy steels being installed in foundries in the future.

Competition from Welding

It was thought some years ago that the rise in the use of fabricated construction and drop stampings would lead to a diminution in the use of steel castings in the engineering industry but, if anything, the last twelve months have seen a tendency for this process to be reversed. Moulding and casting methods offer much greater flexibility in design than either fabricated structures or forgings. With a growing appreciation of some of the lesser appreciated virtues of steel castings there is a measure of considerable hope for the incursion of steel founding into fields which were perhaps hitherto not thought possible. Engineers are beginning to appreciate that the physical properties they usually associate with steel forgings are merely those which are obtained when the test-pieces are taken with the grain lying parallel to the axis of the test-piece, and very different results, particularly in impact value, are obtained when the test-piece is cut with the grain at right angles to the axis of the test-piece.

Steel castings, properly made, do not exhibit this undesirable and almost inevitable feature in forgings of grain flow, and therefore the physical properties of a steel casting can be independent of the position in which the test-piece is cut and the physical properties on balance can be better than those exhibited by the forging. For instance, as typical of what is now being obtained in steel castings, an example can be quoted of a nickel chrome molybdenum casting which showed in test-pieces cut from the actual casting 65 tons tensile strength, 19 per cent. elongation, 40 per cent. reduction of area, and impact values of 35 ft.-lb.—physical properties which are definitely superior to what is normally obtained on transverse tests in even the best nickel chrome molybdenum forging. Engineers will also have been interested and impressed by the results obtained by one of the most prominent automobile manufacturers in the United States in the substitution of centrifugally cast steel castings for drop stampings for automobile parts.

The great homogeneity secured by centrifugal casting and the absence of grain gives a product which is equal, if not superior, to a steel forging. In complicated designs, where due to foundry difficulties fabrication has been thought more practicable, the method of dual construction is being exploited, *i.e.*, where a design *in toto* is too complicated for a casting or where fabrication is difficult and expensive, the method of dividing the structure into two or more parts so that each of the divisions is suitable for casting and subsequently welding various castings together presents possibilities to secure an economic production of the most desirable type.

Grey-Iron Foundry Industry

(*Concluded from page* 21.)

concerned with the well-being of this industry should use every opportunity of endeavouring to produce mixtures of metal which will be suitable as a substitute for such materials as steel, malleable iron and aluminium which, owing to wartime conditions, are obviously at a maximum demand.

While one cannot hold out much hope of all these substitutes becoming permanently made in grey iron, they can at least help to keep up the tonnage of the industry until normal conditions again return.

It is very probable that enormous strides will be made in improving grey iron. One only has to take one's mind back to the time between 1914 and 1918 when necessity caused the development of what was then called semi-steel, which was the forerunner of so many developments in the grey-iron industry of to-day.

THE NORTH LONSDALE HOSPITAL, Barrow, has received as a New Year's Day gift from Vickers-Armstrongs, Limited, shipbuilders and engineers, a cheque for £17,117, the only stipulation being that the money shall be used for covering the cost of needed extensions to the hospital, and that a modern fracture clinic shall form part of them.

The Foundry Pig-iron Trade

By E. J. FOX (Managing Director, Stanton Ironworks Co., Ltd.)

THE market for foundry and forge pig-iron, to which these remarks will be chiefly confined, opened at the beginning of the year under difficult conditions. Notwithstanding a reduction in price on January 1, 1939, of 10s. per ton, the demand continued dull and, in fact, large tonnages representing arrears of old contracts had yet to be taken up. There also remained considerable stocks in consumers' hands as a legacy of the scramble for supplies witnessed in 1937 and the early part of 1938.

These stocks, combined with a pronounced falling-off in demand for castings from normally large consumers such as the building trades and the textile machinery makers, contributed to a general feeling of apathy, notwithstanding the political clouds which were gathering and which, under more normal conditions, might have been taken as an indication that a stock of pig-iron was a wise precaution.

Influence of Steelmaking Demands

Although my interests lie primarily in the direction of foundry and forge pig-iron, conditions ruling in the steel trade must indirectly play their part in influencing the demand for these products. In the early spring of 1939 a shortage of basic pig-iron and steel scrap was again apparent consequent upon the growing requirements of the Government for steel for general rearmament and particularly for the manufacture of air-raid shelters. The transfer of "foundry" blast furnaces to the production of basic pig-iron was envisaged, which contributed to an increase in specifications from the ironfounder, as an insurance against the shortage of steelmaking pig-iron extending to foundry grades, as in 1936. Once impetus had been given, the demand continued to grow and was followed as is usual by an increase in actual consumption.

Cleveland and Scotland

For the purpose of foundry pig-iron, the Midlands (that is to say Derbyshire, Leicestershire and Northamptonshire) are now the backbone of the trade. Manufacture of such well-known brands as Cleveland No. 3 is to-day, and has been for some time in fact, virtually non-existent, the whole of the pig-iron from the Cleveland district being converted into steel for economic and technical reasons.

Tees-side consumers throughout the whole of the year have relied upon the bulk of their requirements being fulfilled from the Midlands. In Scotland also, the light-castings industry of Falkirk is now dependent on the Midlands for a large proportion of its phosphoric pig-iron requirements.

Light-Castings Industry

I am afraid that for this section of our consuming industry it has been a difficult year. Competition from manufacturers of similar products in alternative materials to cast iron has been growing, but it was wisely recognised at the outset that to claim superiority for cast iron was not enough by itself, and accordingly active steps were taken to improve the design and appearance of the cast-iron product with not unsatisfactory results.

Medium- and Low-Phosphorus Pig-iron

As a direct result of the competition to which I have referred, the demands of the modern engineer have become more stringent, and this in turn has resulted in the specifications to the ironmaster becoming more exacting and at times difficult. In order to provide the special qualities of pig-iron required, supplies of ironstone are being drawn from other localities and imported from various countries. The Midlands, which until the last year or two had concentrated purely on their domestic and natural product of a phosphoric iron, now provide a complete range of the various pig-iron grades, with the one exception of hematite.

MR. E. J. FOX

Machine-Cast Phosphoric Pig-iron

This year has witnessed a step forward in the manufacture of pig-iron with the introduction of machine-cast phosphoric iron, which was welcomed by a large section of the trade. The iron in this form has a number of advantages. The general appearance and physical condition are an improvement on the sand-cast pig. There are no sows, which have been such a bone of contention to all foundrymen. The iron is more uniform in composition, and, being free from sand or slag, is not only cleaner but quicker to melt in the cupola. Less limestone is required, and in many instances an improvement in coke consumption has been recorded.

It must be admitted that, because of the rapid cooling, which closes up the grain, foundrymen are no longer enabled to classify their pig-iron, as in the past, on fracture. Therefore the fear is sometimes expressed that the closer grain of machine-cast iron may tend towards hard castings.

If, however, the iron is remelted and cast in sand, it will be found to have a normal open fracture, and I think this fear is more a question of the foundryman's natural dislike of departing from old-established conditions. Certainly in those foundries where machine-cast iron has been given a thorough trial, the experience of the majority has been a strong disinclination to revert to the old sand-cast pig.

There can be no doubt that the use of iron in this form is extending rapidly and will continue to do so, to the extent that in the years to come iron cast in sand may become the exception rather than the rule, as is at present the case in America.

The Future

It is difficult and dangerous to attempt any prophecy on the result which the outbreak of hostilities will have upon the foundry pig-iron trade. Many difficulties and perplexities will confront the industry pending the transition to a full wartime basis. A serious contraction in demand may be expected from the light-castings trade; many have already experienced a considerable drop in their outputs and at the

(*Concluded on page* 28.)

FOUNDRY PIG-IRON BEING MACHINE-CAST AT A WORKS CONTROLLED BY STANTON

Refractory Materials in 1939

By FRANK SCOTT RUSSELL

THE early part of the year was a period of dull demand resulting from small capital expenditure. Capital expenditure will never be made on any large scale except with the support of confidence in the reasonable stability of general conditions, and no confidence could be possible with the Hitlerian ferment brewing no one knew what in the Devil's Kitchens of Germany and Eastern Europe. Violent fluctuations on the stock market and its general depression further weakened confidence and made the raising of capital for new enterprises almost impossible.

The refractories industry suffered along with many others, but spent the lull in further improving its products, and quietly preparing for any eventuality, including the war which many manufacturers felt to be inevitable.

Consolidation in Scotland

Consolidations in the Scottish firebrick industry have simplified the position in the North —Castlecary and Turnbulls are now merged with Glenboig, along with Levenseat (where an unusually high-grade fireclay has been opened out and is being produced in large quantities) and Carlops. Carlops has just put on the market an abundant supply of washed and graded white silica sand of great purity; its introduction happily coincided with the shortage of deliveries of silica sand from the Continent, though the new works (perhaps the most modern in the country) have been building and equipping for a year past.

Levenseat has further increased its output capacity in both silica sand and steel foundry sand and in the last-named has more than filled any gap arising from the difficulty of obtaining Continental moulding sands.

Basic Refractories

Actually there is, neither in England nor Scotland nor Wales any longer any valid reason for importing moulding sand at all. Home-produced supplies fully meet every case.

The principal effect of the war has been, of course, on the basic refractories, August having seen the end of importations of magnesite and magnesite bricks from Austria.

It may well be said that the country has cause to be thankful that British refractories makers had provided themselves with such adequate stocks of raw materials, and had so far extended and perfected their means of production. No difficulty whatever need be experienced by any consumer of magnesite bricks because of the absence of Austrian magnesite.

For several years past several factors including national distrust, and a natural desire to be independent of supplies controlled by a potential enemy, had been gradually reducing the proportion of foreign magnesite goods consumed in the country. British manufacturers are every bit as well equipped as the best on the Continent and have made adequate arrangements for the provision of raw materials.

During the last few years any grounds for buying from foreigners, either magnesite or chrome magnesite bricks, have been very slender ones indeed, and, to-day, British efficiency is such that purchases of foreign refractories are entirely without technical or moral justification.

Early Faults Eliminated

In no department of the refractories industry has so much progress been made during the year that is past than in that of the production of "chrome-magnesite" bricks. Early faults such as the tendency to grow and swell by the absorption of iron oxide have been largely eliminated, the tendency to spall has in certain varieties been entirely overcome and fire-resisting ability has been intensified.

Altogether, the best British chrome-magnesite bricks are productions of which their makers may well be proud and with which their users are almost uniformly satisfied. The use of these bricks in open-hearth furnaces has been greatly extended during the year.

The demand for silica bricks was slight in the early part of the year, and several works were closed down. Since war was declared the call for silicas has been increased to such an extent that the closed works have been reopened, but there is no scarcity of supplies and all demands have been met with ease. The outstanding feature of the year, in this section, is the proved success of the power-pressed silica brick, which has demonstrated its superiority beyond dispute.

Firebrick Trade

In the firebrick trade the demand throughout the year has remained sluggish, and has been but little improved since the advent of war. Makers still suffer from the burden of the increased costs of mining operations, and higher prices for coal, whilst still selling their output at a price which has been for many years uneconomic, and which is about half the price of similar bricks in the U.S.A., whilst, in comparison, American prices for magnesite and silica bricks are more or less the same as ours here.

Comparison with 1914

The outstanding feeling in the refractories industry of Great Britain at this critical moment of our lives, when no one of us knows what the morrow may bring forth, is a realisation of the immense difference between the preparedness of the industry to-day and its state twenty-five years ago, the incomparable superiority of its products, and the enormous extension and increased elasticity of its productive facilities.

Added to this is the strength which has been derived from consolidation and concentration, from co-operation in an industry which is, in most of its branches, amongst the best-organised trades in the country, and a grateful appreciation of the work of the National Federation of the Clay Industries, which under the directorship of Mr. Herbert Halliday has been of vital service to every section and aspect of the trade throughout the year, but more particularly since the advent of war provided new and urgent needs and an urgent demand for still closer co-operation.

The Vitreous Enamelling Industry

By B. B. KENT (General Manager, Sterling Manufacturing Co.)

THE advent of war has affected the vitreous enamelling industry probably more than any of its allied trades. At the beginning of the year most firms were working to capacity, owing to the increased use of vitreous enamel as a finish and a protective material. Many architects and builders were beginning to realise the importance of enamel, and whilst no porcelain enamelled houses have yet been built in this country, many of the railway stations, canteens and shop fronts have used it as a decorative finish.

Further extended uses have been made of enamel in the refrigerator industries, as a number of models are now being produced with the porcelain enamelled exterior as well as interior.

On consideration, it will be realised that most of the articles enamelled are of a more or less luxury nature, and this, coupled with the fact that private building has almost ceased, is the cause of the present scarcity of work. Actually the only part of the industry which appears to be flourishing at the moment is the de-enamelling and re-enamelling of sheet iron fabricated articles, due probably to the shortage of steel plates. As far as it is known no new plants or extensions are contemplated at the moment, although last summer several firms were considering additions to their enamelling departments, due to the increased use of enamel as a finish.

The Institute of Vitreous Enamellers

The Institute of Vitreous Enamellers has on the whole had a very successful season, but here again the war caused the cancellation of the Annual Autumn Conference, whilst the previous crises prevented our American friends from paying us their promised visit.

The Council of the Institute have met several times to consider the wartime activities, and although fortunately there has been no lessening of interest, or resignations from members, it is felt that strict economy must be practised but without affecting the research which is now being carried on in conjunction with the B.C.I.R.A.

On the completion of the term of office as President by Sir Harold Hartley, the Institute has been fortunate in obtaining for their new President Prof. Andrew, of the Sheffield University, but unfortunately circumstances have prevented Prof. Andrew from taking up his active duties yet.

The Institute has, however, suffered a loss by the resignation of Miss E. Christine Elliot (Mrs. Kenneth Hill) as Secretary, after so many years of hard and conscientious work, but has been fortunate in securing the services of Dr. Martin as General Secretary.

The Institute of British Foundrymen

By W. B. LAKE, J.P. (President)

IN spite of the war and its effects which naturally influence any review of the past year, the Institute of British Foundrymen has had a successful year throughout, and the eight months prior to the outbreak of war saw a period of exceptional interest and activity.

The outstanding feature of the year was the International Foundry Congress which was organised by this Institute, and which took place in June. Its preparation occupied much time and energy on the part of the officials and of a large number of members. Fortunately, the date of the Congress coincided with a comparative lull in the international disturbances which we experienced during the spring and summer; this facilitated the presence of a larger number of overseas visitors than had previously been anticipated, and contributed to the undoubted success of this memorable gathering.

I do not propose to review the comprehensive programme in detail, as full reports have already appeared in the FOUNDRY TRADE JOURNAL, but a few important facts may be of interest.

THE INSTITUTE OF BRITISH FOUNDRYMEN.

OFFICERS, 1939-40.

PRESIDENT: W. B. Lake, J.P.

VICE-PRESIDENTS:
Major R. Miles, M.Eng.; D. H. Wood.

PAST-PRESIDENTS
R. Buchanan. (Deceased, 1924.) 1904-1905.
H. Pilkington. (Deceased.) 1906-1907.
F. J. Cook, M.I.Mech.E. 1908-1909.
P. Longmuir, M.B.E., D.Met. 1910-1911.
C. Jones. (Deceased, 1923.) 1912.
S. A. Gimson, J.P. (Deceased, 1938.) 1913-1914.
W. Mayer. (Deceased, 1923.) 1915.
J. Ellis. (Deceased, 1930.) 1916-1917.
T. H. Firth. (Deceased, 1925.) 1918.
John Little, M.I.Mech.E. (Deceased, 1932.) 1919.
Matthew Riddell. 1920.
Oliver Stubbs, M.I.Mech.E. (Deceased, 1932.) 1921.
H. L. Reason, M.I.Mech.E. 1922.
Oliver Stubbs, M.I.Mech.E. 1923.
R. O. Patterson. 1924.
J. Cameron, J.P. 1925.
V. C. Faulkner, F.R.S.A. 1926.
J. T. Goodwin, M.B.E., M.I.Mech.E. 1927.
S. H. Russell. 1928.
Wesley Lambert, C.B.E. 1929.
F. P. Wilson, J.P. 1930.
A. Harley. 1931.
Victor Stobie, M.I.E.E. 1932.
C. E. Williams, J.P. 1933.
Roy Stubbs. 1934.
J. E. Hurst, D.Met. 1935.
H. Winterton. 1936.
C. W. Bigg. 1937.
J. Hepworth, J.P., M.P. 1938.

HON. TREASURER: S. H. Russell.
SECRETARY AND GENERAL OFFICE.
Tom Makemson, St. John Street Chambers, Deansgate, Manchester, 3.
(Registered Office: 49, Wellington Street, Strand, London, W.C.2.)

Highlights

The main portion of the Congress was held at the Dorchester Hotel, London, from June 11 to 17. The total number of registrations was 630, of whom 221 were from countries outside Great Britain, some 22 countries being represented. Notable features were the official opening by the Lord Mayor of London; the Reception given by His Majesty's Government at Lancaster House, at which the guests were received by the Viscount and Viscountess Runciman; the Edward Williams Lecture by Prof. W. L. Bragg, and the banquet which was attended by 520 persons, at which the principal speaker was the Right Hon. Oliver Stanley, then President of the Board of Trade.

No fewer than 32 Papers were presented at the technical sessions, and 16 visits were arranged to industrial, educational and research establishments. The increasing importance of the light alloys in foundry practice has been responsible for the attention given to this subject at recent Annual Conferences of the Institute. The policy was continued at the International Foundry Congress, the light alloys being discussed in several important and representative Papers. A special session, held jointly with the Iron and Steel Institute, was devoted to Papers on steel foundry practice, a recognition of the technical developments in this branch of the industry. Efforts were made to stress the technical and official aspects of the Congress, but a number of social gatherings, including those already mentioned, were organised and a particularly full programme of entertaining and sightseeing was arranged for the ladies.

A congress of this kind cannot be organised successfully without the assistance and co-operation of a large number of people, and on behalf of the Institute of British Foundrymen and of

MR. W. B. LAKE, J.P.

all who were present at the Congress, I wish to express grateful thanks to all those who co-operated in organising and carrying out the extensive programme. We are indebted to a number of the distinguished Patrons for using their influence in many directions; to the Congress Organising Committee; to the authors of Papers and the firms with which they are associated; to the firms who arranged visits to their works; to all who gave such generous hospitality, and to those members who assisted in various other capacities. It is perhaps invidious to single out any individuals for personal mention, but I cannot miss this opportunity of paying tribute to Mr. Barrington Hooper and Mr. Vincent Delport, and to Mr. V. C. Faulkner, the Editor of this JOURNAL, for his work in editing the large number of Papers.

The financial risk involved in organising this function was considerable, but thanks to the generous support of some of the Patrons, of various members of the Institute, of firms in the trade, and of the Foundry Trades' Equipment and Supplies Association, the Institute was free from anxiety in this connection, and the generous donations which were received enabled the Congress expenses to be fully met, with the result that the income balanced the expenditure.

Post-Congress Tour

The Congress was followed by a tour embracing a number of important industrial areas, and a number of districts renowned for their scenic beauty. About 100 overseas delegates and ladies participated in the first week of this tour, and visited the Birmingham, East Midlands, Sheffield and Lancashire Branches. About 40 of the travellers continued their journey for another week and visited the Lake District, and the Scottish and Newcastle Branches.

I had the privilege of participating in this tour, and it is therefore from personal experience that I testify to the generous hospitality of the Branches which were visited, and of their officers and members. The visitors were enabled to see representative British foundries by the courtesy of the respective directors and managements; each Branch entertained very hospitably and interspersed the more serious part of the tour with excursions and social gatherings, and, what is most important of all, the visitors were received everywhere with a cordiality which was more personal than formal, and I know from the many letters which I have received since that they retain the happiest memories of their tour.

THE INSTITUTE OF BRITISH FOUNDRYMEN.

Members.

Honorary	18
Subscribing Firms	74
Members	969
Associate Members	1,135
Associates	129
Associates (Students)	35
Total	2,360
Branches	11
Sections of Branches	5
Committees of the Council and Special Committees	9
Sub-Committees of the Technical Committee	8
Technical and Educational Institutions on which the Institute is represented	12
Branch meetings held during 1939	96

Papers presented in 1939.

Cast Iron	18
Steelfounding	10
Non-Ferrous	16
Moulding, Coremaking and Patternmaking	20
Sands and Refractories	9
Furnaces and Fuels	7
Organisation	3
General Discussions	8
Branch and Section Presidential Addresses	7
Miscellaneous	12
Total	110
Nationalities represented in membership	18
Countries in which members are resident	27
Cities and towns in which meetings are held	15

The Institute is deeply indebted to the Branches, their officials and members, to those who tendered hospitality, to the firms who arranged for visits to their respective works at a time of considerable difficulty, to the General Secretary, Mr. Tom Makemson, whose organisation of the Congress won the admiration of all who attended, and to all those who contributed financially or otherwise to the expenses involved; to all these I tender sincere thanks on behalf of the Institute.

It has been frequently pointed out that the general day-to-day work of the Institute falls into two categories; the first is the work which is carried out continuously and unobstrusively by the Branches, who regularly hold meetings in 15 cities and towns, the second is the work which is carried out by Committees of the Institute as a whole, for the benefit of the members and of the industry in general.

Work of the Branches

In the spring of last year the Branches concluded a most successful session, and many

Papers which were presented before them during that session were of a pioneer character, and will remain the standard references on the respective subjects for some time to come. I would like to pay especial tribute to the newest of our Branches, the South African Branch, which is developing rapidly and has already undertaken educational and technical activities on behalf of the foundry industry in South Africa. It was particularly pleasing that Mr. A. H. Guy, President of the Branch, was present at the International Foundry Congress, and on the Post Congress Tour, and the Paper presented by him on behalf of the Branch at this Congress, on the industrial conditions in South Africa, struck a new note, as it was the first Paper officially presented on behalf of a Branch at one of our Conferences, and the subject matter was new to the discussions of this Institute.

The Technical Committee

The second category of the Institute's work is one which has developed rapidly in recent years and is still growing. It is carried out largely through the Technical Committee, the Education Committee, and the Institute's General Office. My predecessors have paid tribute to the work of the members of the Technical Committee, who give up a large amount of their time and energy to work of a development character. Valuable reports have been issued by various Sub-Committees from time to time, and very shortly the Sub-Committee on Melting Furnaces will publish a report on the various types of melting furnaces used for melting cast iron.

The Institute is represented through its Technical Committee on numerous Sub-Committees of the British Standards Institution. There is also inter-representation between Sub-Committees of the Technical Committee and Corresponding Committees of other bodies, notably the Iron and Steel Institute and the British Cast Iron Research Association. The Institute is also represented by its Secretary on the newly formed Ironfounders' National Committee.

Educational Activities

The Education Committee has been deeply and actively interested for some years, in examinations of a national character, in foundry practice and patternmaking, particularly those conducted by the City and Guilds of London Institute. The number of candidates for the 1939 examination was 195, which is an increase of over 50 per cent. on the average of the previous few years, and the total number of certificates awarded since these examinations were instituted in 1932 is over 600. Similar certificates gained by candidates in the examination of the Union of Lancashire and Cheshire Institutes are also endorsed by this Institute. Another certificate awarded for part-time study is the National Certificate in Mechanical Engineering. No fewer than 200 of these certificates have been endorsed by me and my predecessors, in respect of special foundry subjects taken as part of the National Certificate course.

The number of part-time classes in Foundry Practice and Patternmaking has increased considerably in recent years, mainly due to the encouragement afforded by the existence of the foregoing examinations. The Institute also supports full-time instruction in foundry practice at the University of Sheffield, the British Foundry School, Birmingham, and the Constantine Technical College, Middlesbrough.

The Central Register

The Central Register of persons with scientific, technical, professional and higher administrative qualifications, established by the Ministry of Labour, has occupied much thought and effort on the part of professional institutions during the past year. This Institute has co-operated in the establishment of this register, and is represented on two of the Sub-Committees by its Secretary. About 25 per cent. of the Institute's membership is enrolled on the register, these members having indicated their desire to take up work of national importance in their own occupations. The fact that a comparatively small number have been transferred to other work is due to the fact that most managers and other officials of foundries are already engaged on work of national importance, and are probably carrying out their most useful work in their present employment.

The Institute's own employment register has been particularly active, especially towards the end of the year, and has met with considerable success in its efforts to place members in suitable positions.

War Policy

The outbreak of war naturally caused the officials to review the Institute's programme and its policy under the altered conditions which it was expected would prevail. The programme of Branch meetings for the session had already been prepared, and most of the Branches decided to endeavour to carry out their arrangements as far as possible, until such time as the position became a little clearer and indicated any possible alterations which might have to be made. Events have proved that this decision was a wise one, because in spite of the difficulties of attending meetings due to the black-out and to a large number of members being busily engaged on war work, one found there was a strong and spontaneous desire for members to meet their fellow foundrymen from time to time, to take part in discussions on technical Papers, to exchange experiences, and to participate in the social intercourse afforded by meeting their friends.

The war with its new conditions and anxieties seems to have intensified the desire of many members to avail themselves of the privileges of membership of the Institute, and as a consequence most of the Branches are continuing their programmes of meetings. Some of the programmes have, naturally, been revised, and some Branches are holding meetings on Saturday afternoons instead of on week nights. Practically all the meetings which have been held, however, have been well and enthusiastically attended, and there is every indication that unless some drastic change takes place in the conditions under which we are living, the Institute will continue its technical meetings under almost normal conditions. In passing, it is significant to note that the present membership of 2,360 is a record, and in spite of present conditions, new members are still being enrolled.

The Proceedings

One of the most valuable benefits of membership of this Institute is possession of the annual volume of "Proceedings." Containing as it does a selection from the many valuable Papers presented during the previous year, it forms an up-to-date *résumé* of foundry technical progress and experience. The next volume of the "Proceedings" will be published in March, 1940. It will contain a complete report of all the discussions at the International Foundry Congress, the whole of the Congress Papers and a number of Papers given before the Branches and discussions thereon, and will contain about double the amount of matter of any previous volume.

Opportunity is being taken to alter the format of the "Proceedings," and this volume and subsequent volumes will have a larger page in two-column type, an arrangement which permits of the satisfactory display of large drawings and photographs. The "Proceedings" in its new dress will, perhaps, be rather strange to members who for so many years have been accustomed to the thick black volume; we believe, however, that when the strangeness has passed away, they will appreciate the new arrangement which undoubtedly has many features to commend it.

Honours Conferred

Two of my predecessors in the Presidential Chair of the Institute have been honoured during the year. The degree of Doctor of Metallurgy has been conferred upon Mr. J. E. Hurst as a recognition of his distinguished work as a metallurgist, particularly in the metallurgy of cast iron, and for his work on behalf of foundry education. The other Past-President who has been honoured is Mr. C. W. Bigg, who now holds the position of Director of Iron Castings under the Ministry of Supply. Mr. Bigg's appointment has been well received by the industry, and he will have its full support in his arduous task.

We note with pleasure that a number of our members resident in Australia are among the founders of the new Institute of Australian Foundrymen. We extend to this body a cordial welcome and good wishes for its success. We are particularly pleased that this new Institute was represented at the International Foundry Congress by Mr. W. Hanks.

International Relations

The international aspect has always been strongly emphasised by this Institute, and by the Foundry Technical Associations of other countries. Such international contacts are now difficult, in some cases they are inadvisable, and with some countries they are impossible. They have been of the utmost value to foundrymen in this and other countries, and one can only express the hope that when the conflict is over the valuable development work which has resulted from these contacts may be resumed.

The Future

One is tempted to look into the future and in doing so, one naturally attempts to assess the possible effects of the conflict in which we are now engaged. The members of the Institute are convinced of the value of their organisation during the present difficult days, and its work will continue throughout the war on lines as near to normal as possible. One hesitates to write of the days after the war, but one thing is certain, and that is, that the period of reconstruction will be an anxious one, it will call for co-operation, and in our own industry it will call for all the knowledge, skill and experience that we possess. Technical and professional institutions will have an important duty in this reconstruction period, and as one of these institutions, the Institute of British Foundrymen is fully conscious of its responsibilities and it is ready to meet them.

Foundry Pig-Iron Trade

(*Concluded from page* 25.)

moment have no alternative work from the Government to keep their foundries fully employed.

The contraction from this department may to some extent be offset by an increase in consumption from the engineering section of the foundry industry, but whether cast iron will be allowed to play anything like the part that it did in the last war is uncertain and still a matter for conjecture. There is one thing that can be said without fear of contradiction, and that is that our foundry industry to-day is an efficient and progressive industry and splendidly equipped to fulfil any demand that may be made upon it.

Foundry Research in 1939

By J. G. PEARCE, M.Sc., F.Inst.P., M.I.E.E., M.I.Mech.E.
(Director, British Cast Iron Research Association)

REFERENCE was made in the last review[1] to the publication in December, 1938, of the First Report of the Research Committee on High Duty Irons for General Engineering Purposes. The Report was presented to and discussed by the Institution of Mechanical Engineers, which sponsors the investigation, and during the year the discussion which took place has been published, with the original Report.[2] The work continues and the second report is in preparation. In connection with this work and high duty cast irons in general, reference may also be made to Papers by A. J. N. Smith on "Cast Crankshafts" and "High Duty Cast Irons."[3]

The process evolved and patented by the B.C.I.R.A. for producing fine graphite structures is now well known. One of the properties of the resulting metal more recently established is its complete freedom from openness of grain or porosity. Ordinary grey irons containing flake graphite are apt to be coarser in the centre of thick sections than at the edges and coarser and more open in thicker than in thinner sections. This, to some extent, depends on composition, and the adjustment of relations between silicon, carbon and phosphorus contents, which will give irons not liable to porosity and openness, is now fairly well known. For a given size of casting, the combination of elements which will yield a sound casting is rather restricted for ordinary grey irons, but the treated irons mentioned above are sound and dense, independently of composition. This fact was very strikingly confirmed in an important Paper during the year by West and Hodgson.[4]

While the precise mechanism of graphite formation and the causes which yield fine, as distinct from flake, graphite, are still obscure, the conviction grows that the difference is in some way connected with the presence of non-metallic inclusions, and this explains why much attention is being devoted to the question of separating and estimating these inclusions in pig and cast irons. For other reasons the steel industry is equally interested in non-metallic inclusions, and the whole of this field is being tackled on a co-operative basis through the Oxygen Panel of the Heterogeneity Committee of the Iron and Steel Institute. The Eighth Report of this Committee[5] gave a number of important Papers relating to non-metallic inclusions in cast iron, including one by Colbeck and his colleagues on the chlorine method and two by Austin, one recording the failure of the alcoholic iodine method for estimating non-metallic inclusions in cast iron and the second the development of the aqueous iodine method for the same purpose. A series of pig and cast irons is now being examined by the aqueous iodine method.

In the same Heterogeneity Committee report is found the Second Report of the Ingot Moulds Sub-Committee, with which the B.C.I.R.A. actively co-operates, and which has enabled largely increased lives of ingot moulds to be obtained.

The Foundry School

At the International Foundry Congress held in June, a Paper was presented on behalf of the B.C.I.R.A. by Dr. G. H. Piper on "Bonding Clays"[6] dealing with the preparation and properties of sands containing controlled clay additions of the bentonite and Colbond type.

At the same meeting the present writer presented a Paper on "Foundry Education and Training in Great Britain,"[7] dealing with progress in technical education for all grades of workers in the foundry industry, and particularly with the establishment and history since 1935 of the British Foundry School. It is regrettable to record that at the outbreak of war it was found desirable to close the school for its duration. No alternative, however, appeared practicable, as by the nature of the school the students were all young men of practical foundry experience, who are better able under present circumstances to contribute to the country's war effort in the works with which they are associated. At the same time there is no doubt whatever that the group of students who have passed through the school since its establishment will in the aggregate assist in putting the foundry industry in a very different position to-day from what it was in 1914.

MR. J. G. PEARCE

Mention may also be made of Dr. Donaldson's Paper to the Conference on "The Thermal Conductivity of High Duty and Alloy Cast Irons."[8]

Of Papers on melting practice, mention may be made of those by Braidwood[9] and Buchanan.[10] On the effect of casting temperature, a very comprehensive Paper by Dr. Norbury[11] should place this controversial subject beyond immediate argument.

Roll Hardness

During the year the B.C.I.R.A. has also issued three Special Publications and made them available to all interested. The first relates to hardness testing for chilled rolls.[13] It is well known that the rebound method for determining the hardness of white iron, while on the whole the most suitable for the purpose, is subject to certain difficulties, which make a standardised procedure desirable. Difficulty has also been experienced in competition on the international market from the fact that a rebound hardness instrument, which was formerly made and used in Germany, is not the same as the instrument made and used in this country and in America, and the former instrument gave a higher reading by some 10 per cent. It is hoped that the issue of this publication will eliminate these difficulties in future.

A.R.P. for Cupolas

The second publication, "A.R.P. for Cupolas,"[12] was the result of attention to this problem before war broke out, and is referred to more fully below. Some 2,000 copies of this report have been distributed, but its sale has to be confined to *bona fide* British foundries.

The war has also interfered with the proper application of the third of these Special Publications, "Pig-Iron Grading,"[14] an important report, prepared by the Pig-Iron Sub-Committee of the B.C.I.R.A. under the chairmanship of Mr. P. A. Abernethy, and the result of several years' work by this Committee, which, incidentally, is representative not only of the Association, but of all the pig-iron associations in the country and the British Iron and Steel Federation. The Report for the first time comprehensively grades all British pig-irons, foundry, hematite, basic, cold blast and refined, in such a way that any pig-iron purchaser can be sure of obtaining a composition of pig-iron within certain agreed limits with respect to silicon, phosphorus, manganese and sulphur. In the case of refined irons, total carbon limits are also provided.

Vitreous Enamelling

During the year a scheme of co-operation between the B.C.I.R.A. and the Institute of Vitreous Enamellers resulted in the formation of a Joint Committee, for the purpose of promoting investigations of interest to vitreous enamellers. A full-time investigator is at work, and has paid a number of visits to enamelling plants. Following the Paper referred to in the last review—"Scientific Aids to Control in Vitreous Enamelling"—the Joint Committee decided to set up a Sub-Committee, for the purpose of establishing a recommended method for obtaining chemical resistance tests on vitreous enamel. These will principally be tests on acid resistance. After intensive work a method was evolved and has been presented to the Institute of Vitreous Enamellers.[15] The Joint Committee has also issued its first Special Publication JVI, this being a comprehensive bibliography on vitreous enamelling. It runs to over 100 typescript pages, and is available to all interested at 15s., half price to members of the I.V.E., and free to ordinary members of the B.C.I.R.A.

The war has naturally influenced the work of the B.C.I.R.A. very considerably. By arrangements made prior to the war with the Department of Scientific and Industrial Research, the Association continues to function and acts as a central scientific agency for the industry. The research programme continues normally, except that the work on the Cralfer aluminium cast irons for heat resistance has been completed and temporarily suspended, but, as opportunity offers, these irons will be recommended for purposes for which they prove to be suitable.

Anti-Glare

The Association has also undertaken to act in an advisory capacity to the Home Office in respect of work on anti-glare, that is, the structural modification of cupola furnaces in order to enable them to comply with the requirements of the Civil Defence Act, 1939. Schemes put forward by firms desiring to obtain the State

grant provided for in the Act are considered for approval by the Association's Anti-Glare Committee. The Ministry of Home Security recently arranged for the circulation to all foundries of a letter dealing with this matter, and in view of its general interest this letter is appended.

The Association has endeavoured to promote the extended uses of cast iron, particularly in the present emergency, and this is one of the main objects of the recently formed Ironfounders' National Committee, designed to act in the interests of ironfounders as a whole under the conditions of control now obtaining.

LETTER ADDRESSED TO ALL FOUNDRIES BY THE MINISTRY OF HOME SECURITY

CIVIL DEFENCE ACT, 1939, ANTI-GLARE MEASURES.

The urgent attention of all foundries is directed towards the requirements of the Lighting Order and under the Defence Regulations. All industrial establishments are required to make certain provisions for obscuration of lights and prevention of glare with a view of protection against air attack. This memorandum relates exclusively to the requirements for anti-glare, which in the founding industry chiefly refers to cupola furnaces. Under the Civil Defence Act, a grant up to 50 per cent. is payable by the Government on capital expenditure incurred on approved anti-glare schemes. The British Cast Iron Research Association has formed an Anti-Glare Committee, which is acting in an advisory capacity to the Ministry of Home Security in approving schemes for eliminating glare. Schemes approved by this Committee will rank for grant to the extent of 50 per cent. of the approved capital expenditure involved.

Foundries fall broadly into three groups. Those foundries which confine their operations producing glare to the period from half an hour before sunrise to half an hour after sunset are not required to make any provision against glare at all, since glare emitted during this period is not contrary to the Lighting Order.

Foundries making their own provision with regard to glare and not proposing to apply for the State grant do not need official approval for their scheme, but they must ensure that glare is prevented during black-out hours.

Foundries desiring to work in a way creating glare during the period from thirty minutes after sunset to thirty minutes before sunrise and who wish to obtain grant on the capital expenditure on an anti-glare scheme, are required to obtain the approval of the Ministry of Home Security through the Anti-Glare Committee of the British Cast Iron Research Association. The required procedure is as follows.

Procedure in Applying for Grant towards Anti-Glare Schemes

A scheme for obscuring glare should be drawn up and submitted to the British Cast Iron Research Association, 21, St. Paul's Square, Birmingham, 3. The information should be *sent in triplicate* and should consist of:—(1) A brief description of the work; (2) a drawing, or drawings, preferably in blue-print form; (3) detailed estimates of the capital cost of the work; and (4) probable date of completion.

In preparing the estimates, overhead expenses may be included as a percentage of the cost, to an amount not exceeding the following figures:—

For work carried out by the companies themselves on the estimated cost of labour and materials, 12½ per cent.

For work carried out by contractors to tender and "bought out" items, 5 per cent.

Ten per cent. may be added to the total estimated cost to cover contingencies arising in connection with the scheme.

In cases where equipment for screening glare has already been completed, and it is desired to make a claim for grant, the British Cast Iron Research Association should be notified as soon as possible and the details listed above should be forwarded to them, in triplicate, for approval by the Anti-Glare Committee.

As soon as a scheme receives the approval of this Committee, it will be forwarded to the appropriate department of the Ministry of Home Security. The Ministry will then issue a notice to the firm concerned requiring the work to be completed by a specified date. A copy of the scheme as approved by the Committee will be given as an appendix to the notice. In view of the urgency of the matter, the work should in fact be put in hand as soon as the Committee's approval has been given, without waiting for the formal notice.

A claims form on which the claim for grant is to be made will be sent with the notice. On completion of the work, the claims form should be filled in by the firm, certified by an accountant, and returned to the Ministry of Home Security. Overhead expenses included in the final statement of cost on the claims form will need to be certified as actually incurred, and the contingency allowance will not, of course, be payable unless it has actually been spent. The accountant certifying the cost on the claims form should be a chartered or incorporated accountant or a member of the Association of Certified and Corporate Accountants, and may be in the employ of the firm concerned. The Ministry of Home Security will then arrange for the inspection of the work in order to ascertain whether it is in accordance with the measures described in the appendix to the notice.

Anti-Glare Requirements

This opportunity is taken to clear up various misconceptions with regard to the present situation. The Lighting Order imposes on all industrial establishments the necessity for obscuring glare. To create glare during the black-out period is illegal and renders a firm liable to prosecution. This applies to all parts of the country, regardless of whether a works is or is not in a neutral, reception or vulnerable area. The responsibility for enforcing the lighting restrictions rests with the police. Foundries creating glare within the prohibited period can therefore only work without penalty if they obtain the necessary exemption from the local police authorities. It should be understood that all such exemptions are temporary, are granted on the condition that immediate steps are taken to shut down glare on receipt of the public air-raid warning, and on the understanding that provision is being made for a permanent anti-glare scheme. Firms working on such temporary exemptions who are not carrying out permanent anti-glare schemes are liable to have the exemption withdrawn at short notice, after which there will be no alternative to shutting down during the prohibited period. Foundries creating glare should not argue, because other works in the neighbourhood, *e.g.*, steelworks, blast furnaces or coke ovens, are creating glare, that foundry glare is unimportant. All such works are working under temporary exemptions and are making anti-glare provision and have undertaken to be in a position to shut down glare immediately a warning is received. All foundries must, in the national interest, be in a position to dispense with exemption at the earliest possible moment.

Foundries employing less than fifty people at any one time cannot obtain, under the Civil Defence Act, the grant towards anti-glare provision, although ordinary income-tax rebate is obtainable (at present 35 per cent.); but for the purpose of the Act, if the foundry is part of a larger works, the total labour force can be counted.

There is no offence under the Act through showing glare outside black-out hours even though daytime raids may occur, but it is essential on receipt of an air-raid warning to leave the cupola in such a condition that no glare will be caused during the hours of darkness. Further information is provided on this point in the report issued by the British Cast Iron Research Association to all its members, and available to the industry at 2s., post free, Special Publication No. 4, "A.R.P. for Cupola Furnaces." Some 1,500 copies of this report have been distributed.

The British Cast Iron Research Association is undertaking this work as a national service in the emergency, and will assist foundries in every possible way to comply with their obligations with a minimum of expense and inconvenience, and will advise firms who may wish to make inquiries before submitting a scheme. It must be borne in mind that prior to the war, no experience existed on anti-glare schemes for cupolas, and the necessity for immediate action may result in schemes requiring modification before they are entirely satisfactory. The Committee's approval at this stage, therefore, is not necessarily a guarantee that any particular scheme will be satisfactory.

In view of the pressure on manufacturers and on material, firms requiring equipment on the offchance of their needing to work after sunset are asked to postpone ordering steelwork until firms now working after dark are supplied. If a firm experiences difficulty in getting supplies of steel the Committee will use its offices to expedite the release of material required when informed of the quantity and type ordered and name and address of the steel suppliers, the contractor for the equipment and the firm requiring it.

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[9] FOUNDRY TRADE JOURNAL, 1939, v. 60, March 16, pp. 231-234; March 23, pp. 253-255, 258 and March 30, p. 268.
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[13] A.R.P. for Cupola Furnaces. B.C.I.R.A. Special Publication No. 4, 1939. 16 pp.
[14] Pig-Iron Grading Scheme. B.C.I.R.A. Special Publication No. 5. 1939. 16 pp.
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Technical Development During the War

ADVISORY COUNCIL APPOINTED

The Minister of Supply has set up an Advisory Council on Scientific Research and Technical Development. The Ministry of Supply, through its Directorate of Scientific Research, controls a large volume of scientific and technical work with direct application to military needs. The Advisory Council will ensure that this work is conducted with due regard to recent advances in scientific knowledge, will initiate new proposals for research and technical development, and make recommendations regarding the most effective use of scientific personnel.

The Council, of which Lord Cadman is chairman, will be constituted as follows:—Prof. E. N. da C. Andrade, F.R.S., Professor of Physics, University of London; Mr. E. V. Appleton, D.Sc., F.R.S., Secretary, Department of Scientific and Industrial Research; Sir Joseph Barcroft, D.Sc., F.R.S., formerly Professor of Physiology, Cambridge; Prof. W. L. Bragg, D.Sc., F.R.S., Professor of Physics, Cambridge; Major-General E. M. C. Clarke, Director of Artillery (Military Adviser), Ministry of Supply; Prof. J. D. Cockcroft, F.R.S., Professor of Natural Philosophy, Cambridge; Major-General A. E. Davidson, Controller of Mechanisation Development (Military Adviser), Ministry of Supply; Mr. H. J. Gough, D.Sc., F.R.S., Director of Scientific Research, Ministry of Supply; Mr. H. L. Guy, D.Sc., F.R.S., chief engineer, Mechanical Engineering Department, Metropolitan-Vickers Electrical Company, Limited; Brigadier-General Sir Harold Hartley, F.R.S., Vice-President and Director of Research, L.M.S. Railway, and Chairman of the Fuel Research Board; Prof. I. M. Heilbron, F.R.S., Professor of Organic Chemistry, University of London; Prof. A. V. Hill, F.R.S., Secretary, Royal Society; Prof. R. S. Hutton, Professor of Metallurgy, Cambridge; Sir Robert Robertson, D.Sc., F.R.S., Director of the Salters' Institute of Industrial Chemistry, formerly Government Chemist; Sir Robert Robinson, D.Sc., F.R.S., Professor of Chemistry, Oxford; Mr. J. Rogers, Deputy Director-General of Explosives, Ministry of Supply; Sir Frank Smith, F.R.S., Director of Instrument Production, Ministry of Supply, Director of Research, Anglo-Iranian Oil Company; Prof. R. V Southwell, F.R.S., Professor of Engineering, Oxford; Prof. G. I. Taylor, F.R.S., Yarrow Research Professor of the Royal Society (Engineering); Lieut.-General Sir Maurice Taylor, Senior Military Adviser, Ministry of Supply; Sir Henry Tizard, F.R.S., Rector of Imperial College of Science, Chairman, Aeronautical Research Committee.

The joint secretaries of the Council will be Mr. E. T. Paris and Mr. F. Roffey, Ministry of Supply, Adelphi, London, W.C.2.

High-Duty Cast Iron

By A. B. EVEREST, Ph.D. (Research and Development Department, Mond Nickel Co., Ltd.)

ANY review of 1939 must of necessity take into account the many phases of political activity through which the year has led. Whilst 1939 dawned under the hopes of peace raised by the Munich Agreement, misgivings that Germany would not keep her part of the bargain were already being felt, and by March the country entered into what our leading politicians have called "the twilight of Peace," and the shadow of the war which unfortunately broke out later was already cast over industry. The rearmament programme, already commenced prior to the year under review, was in full swing, and as the political situation developed, so the tempo of the effort in this direction was increased. The ironfoundry industry of the country—except for builders' castings—shared both in the general prosperity marking the earlier months of the year and in the increasing activity associated with the rearmament programme.

The year has been outstanding in the extent to which the high-duty cast irons have come to the front in meeting the demand for quality castings of all types, and especially for national requirements. The national war effort has called for the evolution of many new designs, often involving increased stresses or the necessity for weight reduction, both of which are now being regularly met by the products of the more specialised foundries. Previously many of these parts were made in steel in order to meet the high strength figures required, but it is realised to-day that the modern cast irons can not only provide adequate strength, but by their very nature give cleaner and better castings, and their use relieves the pressure on the steel industry.

The increasing adoption of the high-duty cast irons is based on an ever-growing appreciation by engineers of the possibilities of these new materials. The way for this had already been paved by the drawing up of British Standard Specification 786 and in the publicity given to the high-duty irons by the Institute of British Foundrymen and the technical Press generally. Special mention in this connection must be made of the interest which has been taken continuously in the new cast irons by the Institution of Mechanical Engineers and other bodies representing designers and users rather than producers. The Committee set up by the Institution of Mechanical Engineers to study these materials presented its first report before Christmas, 1938. This report received considerable attention and has undoubtedly had an effect in stimulating interest in high-strength irons. This

DR. A. B. EVEREST

Committee is still in being and industry eagerly looks forward to its further reports.

Specialised Plants

On the foundry side, the increasing demands made by engineers are being met by the installation of specialised plant and equipment to produce castings in the modern high-duty cast irons. Amongst those connected with the foundry industry publicity has been given to the new high-duty specifications through the report of the Cast Iron Sub-Committee of the Institute of British Foundrymen, and the extent to which publicity given in the Press is followed by foundrymen is reflected in the wide interest taken in these special irons. It was, for example, a revelation to note the extensive and enthusiastic discussion on even the most technical Papers presented at the International Foundry Congress held in London in the summer. It is, perhaps, no exaggeration to say that the same Papers would, ten years ago, have been passed over with only the most limited comment.

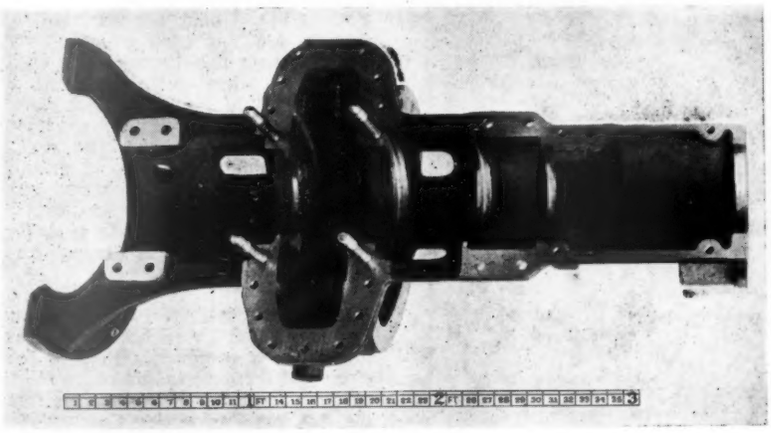
Amongst foundrymen the specialised nature of the modern high-duty cast irons is being more and more realised and, as forecast many years ago by the Editor of the FOUNDRY TRADE JOURNAL, the tendency is increasingly towards the establishment of specialised foundries, or at least bays of larger foundries set apart, generally equipped with special melting units, such as electric furnaces, and devoted exclusively to the production of alloy and high-duty cast irons. On the other hand, modern developments in foundry technique, improvements in plant and equipment and the increasing knowledge now available to all sections of the industry have tended towards the improvement in foundry products generally, so that to-day any foundry with modern equipment and with good foundry control is in a position to meet the higher grades of the modern high-duty cast iron specification.

The improvement in the quality of foundry products is of vital national importance to-day, although it may be said that the present war is even less of a "cast iron" war than the last. The actual requirements for iron castings in war machines in proportion to the requirements for steel, for example, are relatively small. This is in spite of the rapid growth of mechanisation, where large numbers of cast-iron components are required in road transport vehicles and other equipment propelled by internal combustion engines; these parts are, however, of vital importance and generally of a highly specialised nature.

On the other hand, the demand for machine tools and plant for the production of arms and equipment is at present on a large scale, and in this field alone the foundrymen found in the last months of 1939 great scope for the development of high-duty castings.

A Note of Warning

Certain sections of the foundry industry, however, have found themselves in difficulty since the war owing to restrictions imposed on the class of castings which they normally produce. This applies most, perhaps, to the lighter sections of the industry and representations have been made, even in Parliament, that work of national importance should be diverted in order to keep this section of the industry busy in spite of the falling-off of its normal trade. This introduces a special problem since, as mentioned above, the Government requirements for cast iron to-day are nearly all for high-duty irons made to the higher grades of the new B.S. Specification, or alloyed to produce other special properties, such as corrosion- or wear-resistance. The production of these irons calls for plant and technique so entirely different from that normally found in the light-castings foundry that it is questionable whether such a foundry would be well advised to take up the production of these castings. It has been



(Courtesy G. & J. Weir, Ltd.)

PUMP CASING IN HIGH-DUTY ALLOY CAST IRON OF THE NI-TENSYL TYPE. THIS IS A TYPICAL EXAMPLE IN WHICH THE MODERN HIGH-DUTY CAST IRONS HAVE SUCCESSFULLY REPLACED A STEEL CASTING.

repeatedly emphasised that the production of alloy cast iron is not merely a question of the addition of some nickel or other alloy in the ladle of metal, but demands a careful control over the composition of the iron so that the base material is in itself already of high quality and possessing inherently those properties required in the final casting. In this case the alloy addition must be regarded rather as a control to bring out the qualities in the base metal and to produce usable castings. The direct addition of nickel, for example, to a high phosphorus light-castings iron will have relatively little effect on the mechanical properties of the castings and would certainly not result in meeting materially the requirements for high-duty castings to-day. It cannot, therefore, be too strongly emphasised that very careful consideration should be given to all the problems involved and no foundry should undertake lightly to swing over from the production of light castings into the field of high-duty cast irons.

With regard to technical developments, 1939 has not been marked by any very spectacular new discoveries, but has been rather a year of consolidation and expansion, involving the development of many types of alloy irons which have made their appearance in the last decade.

In the production of engineering castings of high mechanical strength, established processes such as Ni-Tensyl and Meehanite have gone steadily forward and many hundreds of vital castings for peacetime applications and the Services have been produced in these materials. In this connection a point of some interest is the increasing attention which has been given during the year to the beneficial influence of molybdenum additions in the high-duty cast irons. Papers published both in this country and abroad during the year have stressed the phenomenally high strengths resulting from additions of molybdenum, generally in conjunction with nickel, in specialised types of base irons.

One of the most active sections of the industry throughout 1939 has been the machine tool trade, which has been working at full capacity to provide plant and equipment for the war effort, whilst also during the year a substantial amount of export business has been done. Perhaps it is on account of the activity in this section of the engineering industry that some of the more important developments have taken place in this field.

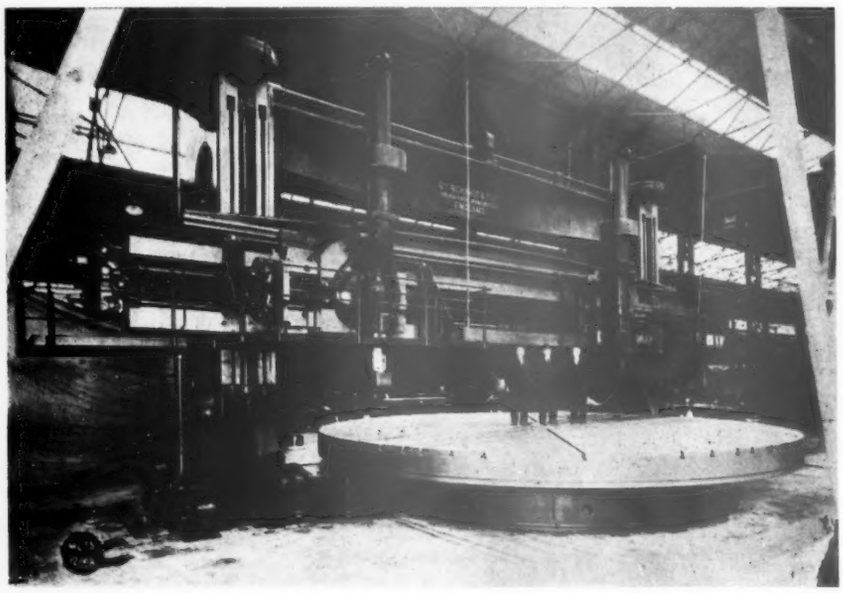
Flame-Hardening

Many large machine tools have been constructed and in these many parts have been supplied in irons showing a tensile strength of 18 tons per sq. in. or over in order to reduce weight or to enable higher stresses to be imposed. A development of some importance and which has come prominently to the fore in recent months is the flame-hardening of the ways and other parts of machine tools subject to severe wear. This development is closely associated with the modern high-duty cast irons, since recent researches have all shown that the use of an alloy iron is most desirable in order to minimise any trouble with distortion or cracking and also to obtain a more even and deeper hard case by the heat-treatment process.

Motor Vehicle Castings

In the transport field, as in previous years, alloy cast irons have been used for many parts such as cylinder blocks and heads where uniformity and machinability are desired. The practice of using cylinder liners in order to allow the employment of the optimum composition of metal for the cylinder walls has grown and amongst the liner materials the corrosion-resisting austenitic iron Ni-Resist has received prominent attention and is now standard on many commercial and other vehicles. Brake drums are also a component of automobile construction calling for specialised physical qualities, and here again the alloy cast irons have continued to develop, providing wear-resisting castings of high mechanical strength.

For wear-resistance more and more attention is being given to alloy irons of the Ni-Hard type and of similar compositions, as a result of which there is no excuse to-day for putting up with only a few hours' life in parts such as "Wheelabrator" blades, "Sandslinger" heads, mill ploughs and the like. The adoption of the alloy irons, often made "on the spot," has frequently raised the life from a matter of hours to one of weeks.



(Courtesy George Richards & Co., Ltd.)

THE LARGEST VERTICAL BORING MILL CONSTRUCTED IN THIS COUNTRY. HIGH-DUTY ALLOY CAST IRONS HAVE BEEN USED EXTENSIVELY IN THE BEARINGS AND GEARING UNDER THE 35-FT. DIA. TABLE.

Corrosion Resistance

The question of corrosion-resistance is very important to certain sections of the trade, particularly in connection with the chemical industry, food handling and the like. Although there is no spectacular development to report in this field, the austenitic cast irons, the high-chromium cast irons and other special materials have all continued to be adopted to an increasing extent by engineers.

If a moral is to be drawn from the situation in the ironfoundry industry as it is to-day, it is surely that the specialised and high-duty cast irons have come to stay and are justifying to the full the forecast that they would extend the field of application of cast irons and recover much of the ground lost from time to time to alternative materials or methods of construction. Unquestionably both in peace and in wartime the demand for the high-duty and specialised materials is increasing, and represents a substantial section of the foundry industry to-day. Experience in 1939, as in previous years, however, has all gone to show that the production of the high-duty cast irons is not one which can be lightly undertaken and success will depend on a careful control over composition and production methods. The year 1939 saw the addition of at least two more foundries devoted especially to the production of high-duty and alloy iron castings, and the signs of the times are that this movement will increase and whatever the future may hold in the political sphere, there is no question that the demand in this section of industry will extend, thus affording the engineer greater facilities for meeting the problems with which he is ever confronted.

Catalogues Received

Air-Hardening Tool Steel. The most interesting part of a catalogue just issued by Darwins, Limited, of Fitzwilliam Works, Sheffield, dealing with their brand Cobaltcrom, so far as foundrymen are concerned, is the fact that it is sold in the form of castings. The castings are used to replace intricate dies and tools difficult of manufacture by the usual tool-room methods, and for revolving wood cutters. A further use is for Go and No-Go gauges, where a record of 30,000 inspections has been made without measurable alteration in size.

Cranes. Book 197 just issued by Herbert Morris, Limited, of Loughborough, carries the interesting claim, "The world's largest crane makers." As this is the first time we have noticed it, we offer our congratulations to the firm in reaching such eminence. The cranes dealt with in this brochure are of the petrol-electric or diesel-electric portable type. The manœuvrability associated with their obviously general-purpose application are factors which should be borne in mind by foundry executives planning the transport arrangements in connection with existing or new buildings and extensions, as their employment may solve knotty problems. The book is available to our readers if they write to the publicity manager at Loughborough.

Materials Handling. As most of our readers are aware, we have—because perhaps we are maladroit—a profound dislike of folders. We either get them upside down or fail to see half of their contents. However, one received from the Aabacas Engineering Company, Limited, of Birkenhead, behaves itself rationally and discloses several interesting solutions of handling problems, some of which are foundry applications.

Foundry Equipment During 1939

By G. E. FRANCE (President, Foundry Trades' Equipment and Supplies Association)

THE year 1939 has been an extremely busy year for the makers of foundry equipment. In the first three quarters of the year much was being done by many foundries in the extension of their plant and in the replacement of obsolete plant, whilst the advent of the war in September focused attention upon immediate means for increasing production, which is causing foundry equipment manufacturers to be taxed to the limit of their capacity.

In the earliest part of the year attention was being directed to the compliance of foundry equipment, particularly melting equipment, with the A.R.P. regulations, and satisfactory means having been discovered for overcoming the effect of glare, the melting equipment manufacturers have been pressed in the supply of these devices.

The last year has largely been one of development of existing equipment, rather than the introduction of new devices. There have been exceptions, notably the introduction, during the year, of devices for extending the principles of sand blowing to moulding practice.

Effect of War Conditions

The incidence of war resulted, unfortunately, in the postponement of the Shipping and Machinery Exhibition with its accompanying Foundry Section. Much had been done in the way of preparation for this exhibition by manufacturers, and the inability to hold the exhibition was undoubtedly a great misfortune. Since then, however, the expansion generally has, undoubtedly, caused manufacturers to be extremely busy

As mentioned already, 1939 has been noteworthy rather for the development of existing equipment than for the introduction of new equipment, and almost every department of foundry equipment records interesting developments of individual plant. The year has seen considerable developments in moulding machines, which are improving in efficiency yearly, casting cleaning practice has benefited by the further extension of the airless sand blasting systems, cupolas and melting furnaces have been improved, a considerable extension in core blowing and mechanical methods of core making is recorded, the installation of modern core and mould drying equipment has appreciably expanded, greater attention to the control of moulding and core sand has resulted in further expansion in the installation of sand preparation and mixing plant, whilst, during the year, foundry mechanisation has progressed rapidly. In this connection, it is interesting to note that the non-ferrous and light alloy foundries have particularly been the subjects of mechanisation during the year.

MR. G. E. FRANCE

Science Materialises

As the dissemination of scientific information about foundry processes becomes wider, so does the acknowledgment paid by foundrymen to scientific control of their materials and processes. The extremely successful International Foundry Congress held in London in June well illustrates this, and, undoubtedly, as the foundry industry applies scientific control to its operations, the more desirable is discovered the application of modern equipment and of foundry mechanisation. The year 1939 has seen continued the evolution of these processes and equipment, and plant which was regarded, not many years ago, as revolutionary, is now commonplace, and equipment manufacturers are having submitted to them problems in developments which are full of interest and promise to the greater efficiency of the industry, and which betoken the growing appreciation of the founding industry's co-operation with science.

The incidence of the war, undoubtedly, will give a considerable impetus to these processes. Already, in many instances, foundries are being expanded, or new foundries being built, on completely mechanised principles, which, it is hoped, will enable the full benefit of the extensive experience of the foundry equipment manufacturers to result in the greater efficiency of the founding industry. Undoubtedly, as the demand becomes more apparent for the production of the maximum amount of castings, in the minimum time and with the minimum labour, the use of every conceivable method of scientific or mechanical nature to achieve these ends will become imperative.

The Future

In 1940, the manufacturers of foundry equipment look forward with confidence to the opportunity of placing their knowledge and their capacity at the disposal of the foundry industry in this respect. Experience is showing that those innovations which, in the past decade, were of a pioneering nature and regarded askance, have, in many instances, adequately proved their value, and there remains much to be done in the way of development of these methods and machinery, as well as in the way of the amplification and full exploitation of newer ideas.

Rising Metal Prices

THE old year went out with a flourish of trumpets in the non-ferrous metal trade, for hard on the heels of the decontrol of tin which jumped swiftly to £275 came Order No. 5 from the Ministry of Supply announcing an increase in the official maximum values of copper, lead and zinc to the tune of nearly £10 per ton. To say that all concerned were surprised is an understatement of the feelings of the trade at this sudden readjustment, for while rumours had been current that stability at the September levels was threatened, the extent of the upswing was certainly a long way from any uninformed estimate. Part of the additional charge is, of course, due to the fact that these control maxima now include the cost of delivery from port to destination, and since in these uncertain days that charge may well be relatively heavy, the change over from a c.i.f. to a delivered basis bears heavily perhaps on those consumers situated near to the seaboard. Some increase, too, was probably inevitable on account of higher ocean freights, but in view of the success of the convoy system by sea and air the incidence of marine war risk insurance was no heavier in December than it was in September.

Since the increase all round is to the order of £10 per ton it follows that proportionately the rise in lead and zinc is greater than in copper; as a matter of fact it amounts to something approaching 50 per cent. This is certainly pretty drastic and the trade has been rather staggered by such a sharp increase in the value of two metals both of which seem to be in good supply.

As always happens there has been a certain amount of grumbling from people who for one reason and another feel that they have had a hard deal. Those for example who were bulls of copper, lead or spelter on the Metal Exchange and parted with their holding at the official maximum prices fixed on the outbreak of war, are inclined to look back with regret to the settlement at the end of October. There may be others who found themselves short of cover when the increase came on December 18, but here it would appear that anyone in that position must have been too confident that stability had come to stay, because the Control announced that licences dated December 16 and earlier would be valid to secure cover at the old prices, provided they were lodged at Rugby by December 28. This certainly gave some help at a difficult time for the increase in the quotations came just before the Christmas holiday.

One trouble arising in connection with announcements made by the Ministry of Supply, especially when it is a question of vital changes in procedure or prices, is the time lag in dissemination of the news among interested parties. There are complaints of delay in obtaining copies of the Order, and it would certainly be a step in the right direction if the authorities could arrange to give information to the Press in order that early publicity would be achieved. As a result of this lack of knowledge of a vital alteration in metal values until quite late in the day, Monday, December 18, will not easily be forgotten by some traders who, perhaps unfortunately for themselves, made sales on the basis of the old values in ignorance that a change had occurred. On the other hand it is being suggested that some people have done very well out of the rise in metal values, for it is thought that certain types of scrap which could be secured without the formality of a licence have been purchased and hoarded in anticipation of an upward movement. This may or may not be a fact, but if it is so there is not as yet much sign of holders of old metals showing any desire to take a profit on such transactions.

Non-Ferrous Metals in 1939

EMPIRE CO-OPERATION IN ENSURING SUPPLIES

(By Our Metal Exchange Correspondent)

IT is difficult to divorce any review of events during last year from the outbreak of war in Europe and the shadow of that impending event which lay heavy across all activities, whether social, commercial or political. During much of the eight months' period which preceded Germany's onslaught on Poland there existed tension more or less severe, and the course of prices in Wall Street served to show that in the United States the gravity of the situation was fully realised. It will be remembered that but a short time elapsed after the crisis in the autumn of 1938 before German intentions were shown in their true light, and 1939 ushered in an all-round intensification of our rearmament and A.R.P. efforts.

In April, a Ministry of Supply was created, and soon after came the introduction of conscription, which made it plain enough to most people in this country that our Government had no intention of putting up indefinitely with German aggression and bad faith. Throughout the year, demand for the non-ferrous metals was on a big scale, but prices kept at a very reasonable level, for, although business was good here, things were not very wonderful in the United States, and the long-awaited uplift in trade in that country did not materialise.

The outbreak of hostilities, of course, brought a sudden change, and the demand for nearly all commodities rapidly increased. In the forefront of this demand stood the call for metals, and the situation in the United States altered almost overnight, for Wall Street assumed a very much more animated appearance, with a sharp advance in the prices of all four base metals. In this country, the Ministry of Supply took charge at once, and controllers were appointed to regulate supplies and fix maximum prices for a number of commodities. The control in copper, lead, tin and spelter was established at Rugby, and a licensing system put into force, which, in spite of some inevitable misunderstandings at the outset, speedily settled down into a regular routine. In spite of criticisms from some directions the control functioned smoothly, but the effect of putting the supply of metals through one channel was responsible for depriving merchants and others of much of their normal business. Moreover, the Metal Exchange, which closed its doors on August 31, did not reopen except for trading in tin, and this led to much dissatisfaction, as a result of which representations were made to the Ministry of Supply for a modification of the arrangement.

At about the end of October, an Order fixing a high limit for the prices of a number of classes of scrap was issued, the object of this being to enable consumers to secure supplies of old metals, of which it was believed a very considerable tonnage existed in the country. Prior to the issue of this Order holders of scrap metals were in many instances securing very high prices for their material.

A further adjustment in the maximum prices of scrap was announced in mid-December, when the Control of Non-Ferrous Metals (No. 5) Order, 1939, lifted the quotation for the highest grade of copper scrap to £57 10s. ex-works, and that of brass to £49 ex-works.

COPPER

The year opened with standard copper at £44 12s. 6d. and wire bars at £50 15s., the price on the domestic market in the United States being 11¼ cents delivered Valley. Business was rather quiet, and in America consumers were indulging in one of their periodic buyers' strikes in an endeavour to compel the producers to lower their selling limit. On the home market, American sales for December, 1938, totalled only about 12,000 tons. On January 10 there was a sharp drop on the London market, in standard to £43 12s. 6d., and in wire bars to £49 10s., while three days later values were some 15s. lower. The cause of the weakness was the appearance of the December statistics, showing an increase of about 32,000 tons in world stocks of refined copper, with a decline in deliveries to American consumers. By January 27, standard was under £42 and wire bars had declined to £48 5s., but reports of curtailment in American production engendered a more cheerful feeling, and the month closed with standard at £43 and wire bars at £49 5s.

Price-Cutting in America

During February the price in the United States was maintained at 11¼ cents by the producers, but secondhands were still cutting to 10 cents. In London, values dropped to £41 11s. 3d. and £47 10s. on February 15, but after further fluctuations the month closed rather higher, although trading continued to be very quiet. By mid-March wire bars had recovered again to £49 5s., with standard at £43 10s., but the likelihood of an export tax on Chilean copper had an unsettling effect, although eventually the proposal was dropped.

With April came a rather easier tendency, but the wide spread between standard and electro, which had been such a feature of the London market, showed no sign of narrowing. In fact, on April 11, with the producers in the United States down to 10¾ cents, standard was at £42 and wire bars at £48 15s., while about a fortnight later Customs smelters in the States were at 10 cents, standard at £41 2s. 6d., and wire bars at £48 10s. The lower price in America, however, attracted buyers, for the demand for export was excellent, and, on the strength of brisker trade, the quotation in New York moved up by 25 points; but London did not react at all strongly to this, and in America buyers lost interest at 10¼ cents, so that the upward movement rather fizzled out. Consumption across the Atlantic was not at all good and, although conditions outside America continued to be very favourable, this did not seem to help matters on the domestic market. In London, the spread between standard and electro was practically £7 on May 17, but on the following day wire bars dipped to £47 12s. 6d., and there was talk of copper production being cut outside the U.S.A.

French Purchases

Throughout June the tone of the market was very steady, with only minor fluctuations in values, but July brought a firmer tone, June sales in the States being 66,000 tons, with news also of the purchase by France of some 50,000 tons of copper from America. During the first ten days of July sales in the U.S.A. on the domestic market reached a total of 150,000 tons, and on the 10th of that month wire bars reached £50, but this was not maintained, 10s. or 15s. being lost as the month went on. Nevertheless, the American domestic price struggled up to 10⅜ cents.

Towards the end of July values began to firm up, and the month closed with standard at £43 11s. 3d. and wire bars at £49 15s., with an advance of 5s. on the following day. With America responding to this upward movement in the shape of a 25 point advance in the Customs smelters' price, the London quotation moved up to £50 10s., with a further jump to £51 5s. In America, values were firm, with Japan reported to be paying the equivalent of 10.75 cents c.i.f. for supplies. Business in the States had brightened up considerably, and the turnover on the domestic market was very good, although many people felt that the producers were rushing values up too quickly. In London, it was Bank Holiday time, but with electro at the year's highest there was plenty of optimism, and the market wore a cheerful appearance. As a matter of fact, the market rather boiled over after the holidays, and the publication of the eagerly awaited July copper statistics did not help much, for instead of an anticipated reduction of 30,000 tons in world stocks, this amounted to only some 17,000 tons. The market, however, noted with satisfaction a reduction of 15,000 tons in production of refined copper. The export figures attracted a good deal of attention, for America parted with 16,000 tons during the month, and this virtually constituted a record. At about this time it was announced that production outside the States would be increased by 10 per cent. to 105 per cent. of the standard tonnages, but the market received the news without weakening. Throughout August there had been persistent buying of cash standard warrants, as a result of which the contango had practically disappeared by the middle of the month. In fact, on August 18, a backwardation of 1s. 3d. made its appearance, and this widened to 5s. five days later.

Export Embargo

Throughout the greater part of last year the wide spread between standard and electro made rough copper a favourable purchase, and one way and another quite a lot of copper was taken up by consumers in this country and abroad. In August, Germany entered our market quite suddenly for a considerable tonnage, and on the 25th, after the Government had placed an embargo on exports of certain commodities, including metals, there was a jump of 25s. in standard and of nearly £2 in electro, the movement being mainly due to depreciation of the £ against the dollar. This was, of course, on account of serious developments in the international situation, and on August 28 standard advanced further to £45 18s. 9d. for cash, with a contango of 5s., and wire bars to £54 10s., the electro price being naturally more sensitive to exchange movements than standard. Three days later the Metal Exchange closed its doors with standard copper at £44 17s. 6d. cash, £45 5s. three months, and wire bars at £53 10s., the domestic price in America being 11 cents. So ended what may be called the period of normal trading in 1939, for apart from a small volume of business in tin on the Exchange operations in futures have remained suspended.

On the outbreak of war the control of non-ferrous metals was taken over by the Ministry of Supply, Capt. Oliver Lyttelton being appointed Controller, with headquarters at Rugby. Maximum prices were fixed, as

follow:—£51 c.i.f. for electro, £49 10s. for best selected, and £46 for rough copper; to these, of course, must be added the cost of delivery to the consuming point. In the early days of the war an addition was made for marine war risk insurance at £2 per cent., and in the case of material ex-warehouse commodity war risk insurance at ½ per cent. per month, but later both of these items were withdrawn, and where they had been charged credit was given. Consumers were therefore placed in a very favourable position as regards price, particularly as in the United States the domestic quotation advanced to 12½ cents. It speedily became evident that there would be a big demand for copper, not only from the belligerents, but also from consumers in America, where buying developed on a spectacular scale. Following negotiations between the French Government and the American producers it was announced that 300,000 tons for delivery over twelve months had been secured by our ally, part of this tonnage, however, to come from Chile and part from the Belgian Congo. It had already been announced that the Ministry of Supply in London had concluded a very large deal with the Canadian and Rhodesian producers, the former purchase at £48 10s. f.o.b. Canadian port, and the latter at a price closely approximating to that ruling just before the outbreak of war. The settlement of outstanding positions on the Metal Exchange on October 31 released a certain amount of standard copper ex-warehouse which was taken over by the Ministry of Supply.

Just before Christmas a new Order by the Ministry of Supply made an upward adjustment in the maximum prices of copper, all quotations being on a "delivered buyer's premises" basis. Electrolytic was raised to £62, with other grades in proportion, no price, however, being given for blister copper.

TIN

The year opened with the price of cash tin at £217 5s. and three months 20s. dearer, but demand was not too good and the December figures were rather disappointing. In the United States, tinplate production was running at between 35 and 40 per cent. of standard, and a downward drift set in which took the price down to £213 10s. by January 25, while the following day saw the quotation £4 lower. The end of the month brought a backwardation of £1 2s. 6d., and there was talk of a scarcity of early metal. In the middle of February three months' tin stood at £211 5s., and on March 1 cash was £215, with a backwardation of 10s. Consumers were adhering to their aloof attitude, and the position of the Pool was not too happy. During the second half of March the quota for the second quarter was fixed at 40 per cent., a reduction of 5 per cent. The March figures showed a fall of 500 tons in total visible supplies, and this reversal of the trend brought firmer markets, so that after moving upwards through April under the spur of brisk buying in the States, May 1 saw the cash price at £225 10s., with a backwardation of £2 5s. This was the highest price since October, 1937, but ten days later saw £226 marked up for cash, with a backwardation of £2 10s., and at this stage the Pool was lending tin to the market to ease the situation. In May, deliveries amounted to 10,000 tons, while in the U.S.A. tinplate operations were running at about 70 per cent. of standard, which was a marked improvement since the beginning of the year. For the third quarter production was announced at 45 per cent., and June saw a much firmer price trend, £227 15s. for cash being reached on June 14, £229 10s. a week later, and £230 on the last day of the month, but the nearby position was then very difficult, with a backwardation of £5 10s.

Now began a period of stability with the cash price at £230 and minor day-to-day variations in the forward quotation, which remained all the time at a discount. Business, both in this country and in America, was quiet, with the American tinplate trade off to about 65 per cent., compared with 70 per cent. earlier in the year. On August 23 the backwardation was £6 5s., but, as the tension deepened, this narrowed to £2 15s., and on August 31, when the Exchange closed its doors, the quotations for tin were £230 for cash and £226 15s. for three months.

Rapid Increases in Production

Early in September it was announced that the quota for the third quarter would be 60 per cent., as also for the last quarter of the year, and on September 12 the quota for the third quarter was lifted again to 80 per cent., which had the effect of releasing some 10,000 tons of metal, much of which was available at the mines for early delivery. Trading in tin continued on the Metal Exchange, and values drooped to £228 15s. for cash and £226 15s. for three months, the maximum levels fixed by the Control being £230 and £231 10s., respectively. In America, however, the market went mad, and September tin rocketed to 65 cents, roughly equivalent to £360 per ton. A good deal of grumbling occurred in this country over restrictions on trading, but it was announced that dealers would be allowed to buy at a slightly lower level than consumers, while sales to America would be permitted at something over £230. The September figures showed an increase of about 5,000 tons in total visible supplies. Meanwhile, in an attempt to quell excitement in New York, the quota for the third quarter had been raised by stages to 120 per cent. of standard. The October figures showed an increase of 7,000 tons in total visible supplies, but this did not prevent the quota for the last quarter of the year being lifted from 70 to 100 per cent. It was also announced that for the first quarter of 1940 the quota would not fall below 60 per cent. Towards the end of November, supplies of ore began to move to this country rather more freely, and the tension due to a scarcity of metal was somewhat relaxed, but the position nevertheless remained difficult.

Early in December the market received something of a bombshell in the shape of an announcement that tin was to be decontrolled and that the quota for the first quarter of 1940 would be 120 per cent., which, in effect, meant that restriction was abandoned. The immediate effect of decontrol was to cause a sudden rise of £42 to £272 for cash, three months being quoted at £268 10s., but, although values were talked higher, there was a downward turn following the initial jump and on December 14 spot tin was no better than £260 5s., with three months at £257.

LEAD

The year opened with the price of lead at £14 18s. 9d. for spot and £15 3s. 9d. forward, but a fortnight or so later values were 10s. lower The trouble with lead throughout the first eight months was that while the call from the cable industry and the battery trade was excellent, the building trade was quiet by comparison with 1938.

Towards the end of July a firmer trend became apparent, and £15 was reached on the last day of the month, a further advance to £15 10s. on August 2 being encouraged by an increase of 10 points in the American price. Heavy buying of early metal took the spot price to £16 5s. on August 8, with a backwardation of 1s. 3d., and it is probable that much of this was on German account. Following this, there was a fall to £15 16s. 3d. and a recovery to £16 5s. on August 21, but a week later, with the clouds of war rising on the political horizon, spot had climbed to £16 15s., with forward metal 5s. cheaper. The last day of the month, when the Exchange closed its doors, saw spot at £16 12s. 6d. and forward at £16 6s. 3d. On the outbreak of hostilities, maximum prices were fixed at:—Empire £17 ex-ship, £17 12s. 6d. ex-warehouse; foreign, duty for buyer's account, at £16 12s. 6d. ex-ship and £17 5s. ex-warehouse. With the declaration of war came an insistent demand for the metal, and, since foreign metal was not attracted to our market, where the control price was considerably below the world price, the position was not any too comfortable. However, the Empire has a very large production of lead and there is no reason at all to expect that this country will not be able to secure all the lead required during the period of the war. Finally, in December, the Control maximum price was raised to £25 delivered buyer's premises, with English lead at £26 10s.

SPELTER

The year opened with spelter at £13 15s. for spot and £14 for forward, but demand was not too good, for uncertainty regarding the revision of the duty made users cautious. There was, of course, an encouraging demand for spelter in connection with galvanised sheets for A.R.P. shelters, but supplies were very ample. On January 26 the value was £13 10s. for spot, and spelter was within 13s. 9d. of the lead price after opening the year at a difference of £1 3s. 9d. The market continued to be uninteresting, with minor fluctuations which, however, took the quotation down to £13 6s. 3d. in February. Stocks were rather on the upgrade, and the coming of the Zinc Cartel hung fire, for there was no word of the duty revision going through. On April 4, spot spelter was no better than £13 2s. 6d., but two days later it was £13 11s. 3d. Later in the month, premiums for Empire metal showed an upward tendency in the face of an excellent demand, but the market did not rally in sympathy. May, however, brought a better tone, and on May 24 the quotations were £13 18s. 9d. spot and £14 forward, for it was known that the duty was to be increased to 30s. Actually, the new rate came into force on May 26, and the month closed with spot spelter at £14 6s. 3d., with a backwardation of 1s. 3d. The new duty was not popular either with the Metal Exchange or with consumers, but it was recognised that the scheme would enable British production to carry on successfully.

The volume of buying in anticipation of the revised duty was considerable, and its aftermath was a quiet spell during which demand was poor. Towards the end of June there was an improvement in business, as consumers came reluctantly to the conclusion that the higher price had to be faced, but on June 30 the market quotation was no better than £14 1s. 3d. In July, it was reported that the preliminary talks anent the Zinc Cartel had ceased, with no knowledge of how or when they would be resumed. As the month went by values improved slightly, to reach £14 13s. 9d. on July 31. In the United States values were moving upwards, but in London the price stayed around £14 10s., until the sudden development of an acute tension in the international situation took the price to £14 17s. 6d. on August 25 and £15 16s. 3d. on the following day. August 31 brought the closing of the Exchange with spot at £15 3s. 9d. and forward at £15 2s. 6d. On the outbreak of war official maximum prices were fixed as follow: G.O.B. foreign, duty for buyer's account, £15 ex-ship, £15 12s. 6d. ex-warehouse; Empire, including domestic, £17 5s. ex-ship, £17 17s. 6d. ex-warehouse; high-grade zinc, £18 ex-ship, £18 12s. 6d. ex-warehouse. In December Control Order No. 5 raised these to £25 15s. delivered for G.O.B., £26 10s. for Empire, including domestic, and £27 5s. for high-grade zinc.

News Highlights of 1939

A SURVEY OF THE INDUSTRY MONTH BY MONTH

January

THE New Year's Honours List contained the names of industrialists and scientists associated with the founding industry. Sir Frank Smith, a former secretary of the Royal Society, was promoted to a G.B.E.; Dr. J. D. Pollock, at one time chairman of the British Oxygen Company, was created a Baronet; Mr. E. J. George, a director of Consett Iron Company, and Mr. E. R. Canning, of W. Canning & Company, Limited, were created Knights.

Mr. R. G. Russell, an Australian member of the Institute of British Foundrymen, was included in the National Committee to investigate the production of aero-engines in the Dominion.

Mr. R. C. Tucker was elected President of the Sheffield Metallurgical Association.

General Refractories, Limited, celebrated their silver jubilee and the 60th birthday of Mr. F. S. Russell at a banquet held in Sheffield.

Mr. Peter Bennett was re-elected President of the Federation of British Industries.

The trade unions acting for the workers engaged in the production of rainwater goods accepted a reduction of 5 per cent. from the percentage bonus.

About 64 new members were elected at a Council meeting of the Institute of British Foundrymen held in Birmingham.

The first order for steel for A.R.P. shelters was placed.

The eminent American metallurgist, Prof. Albert Sauveur, died. He received the Bessemer Medal in 1924.

The Annual Dinner and Dance of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen was attended by 200 members and guests.

February

Mr. John Craig, C.B.E., celebrated the jubilee of his connection with Colvilles, Limited. It was marked by a presentation from the staff.

The deaths were recorded of Mr. Kenneth Hill, aged 37, who was well known to vitreous enamellers, and of Mr. A. J. J. Arnold, moulding sand quarry owner, of Leighton Buzzard.

The Annual Dinner of the Lancashire Branch of the Institute of British Foundrymen was as successful as ever.

A mock trial, "Iron Castings *versus* Steel Fabrications," was held in the Hall of the Institution of Mechanical Engineers. It was jointly sponsored by the London Branch of the Institute of British Foundrymen and the Institute of Welding.

The death was recorded of Mr. E. C. Ransome, chairman of Ransomes, Sims & Jefferies.

Sir John Simon, the Chancellor of the Exchequer, was the principal guest at the Annual Banquet of the British Iron and Steel Federation. There were more than 1,500 members and guests present.

Mr. James Henderson was awarded the Bessemer Medal.

The death was recorded of Prof. Henry Louis, the eminent mining and metallurgical engineer. He was 83 years old.

The Fonderia Milanese di Acciaio was honoured by the presence of the Duke of Bergamo on the occasion of the celebration of its Golden Jubilee.

The death took place of Mr. J. B. Corrie, the well-known engineer.

Mr. G. E. France was elected President of the Foundry Trades' Equipment and Supplies Association.

March

Dr. Desch presided over the Annual Meeting of the Institute of Metals. Sir Kingsley Wood, Secretary of State for Air, was the principal guest at the Annual Dinner.

Mr. William Rennie, chairman and managing director, Federated Foundries, Limited, was elected President of the Combustion Appliance Makers' Association.

Keith, Blackman, Limited, established themselves in the new model factory at Tottenham.

Nearly 800 employees attended the annual works dinner of Qualcast, Limited, at Derby.

Mr. Jean Lobstein was elected President of the Association Technique de Fonderie (France).

The award of the honorary degree of Doctor of Laws to Mr. Joseph Ward, chairman of T. W. Ward, Limited, was announced by the Sheffield University authorities.

Mr. H. James Yates, for many years chairman of Radiation, Limited, announced his retirement from business.

Further Civil Defence Measures estimated to cost over £25,000,000 were announced.

A new note was struck by the publication of a Paper by Dr. Froggatt on "Foundry Work in Dentistry."

April

Mr. E. Bruce Ball, managing director of Glenfield & Kennedy, was elected President of the Institution of Mechanical Engineers.

The Duke of Gloucester visited the foundries of G. & J. Weir, Limited, of Cathcart.

Mr. Barrington Hooper and Mr. A. L. Key were respectively elected Presidents of the London and Lancashire Branches of the Institute of British Foundrymen.

More than 170 tons of metal were used by Brightside Foundry in the casting of an ingot mould for the English Steel Corporation.

Mr. Malcolm Brown was elected President of the Sheffield Branch of the Institute of British Foundrymen.

The Council of the Institute of British Foundrymen elected 74 new members at a meeting held in Glasgow.

Many large shipbuilding orders were booked.

Sir William Bragg, President of the Royal Society, was awarded the John J. Carty medal by the National Academy of Sciences (U.S.A.).

May

Mr. Alfred Chester Beatty, the hon. President of the Copper Development Association, received the honorary degree of LL.D. of Birmingham University.

The death was recorded of Col. J. S. Ruston, chairman of Ruston & Hornsby, Limited. He was 70 years old.

The Government made an urgent appeal to industry to proceed with A.R.P. for employees.

The Annual Meeting of the Iron and Steel Institute was held in London under the Presidency of the Earl of Dudley.

Mr. S. Carter was elected President of the West Riding of Yorkshire Branch of the Institute of British Foundrymen.

Sir Kingsley Wood visited the Banbury works of the Northern Aluminium Company.

The Annual Conference of the Association Technique de Fonderie was held in Paris. It took the form of a one-day meeting so as to enable a maximum number of the members to attend the International Congress. Mr. V. Delport received the Association's medal.

June

Mavor & Coulson received a large order for salt cutters for use in the mines in Rumania.

The Government decided to create a Ministry of Supply.

The death of Sir George H. Kendrick, an ex-Lord Mayor of Birmingham and a director of Archibald Kendrick & Sons, Limited, was recorded.

The International Foundry Congress, attended by well over 600 delegates from every manufacturing country in the world, was held in London under the chairmanship of Mr. W. B. Lake, J.P. About 35 technical Papers were presented. The programme included a Government Reception, at which Lord Runciman was the host; the banquet at which the Right Honourable Oliver Stanley was the principal guest; a reception given by the President and Mrs. Lake, and a garden party at the home of Mr. and Mrs. Barrington Hooper. There were numerous visits to foundries and places of interest. Thanks to the wonderful organising ability of Mr. T. Makemson, the Congress was the most successful ever held. The E. J. Fox medal was awarded to Dr. H. A. Schwartz, of the National Malleable & Steel Castings Company, Cleveland.

Ohio, and the Oliver Stubbs medal to Mr. J. G. Pearce, Director of the British Cast Iron Research Association. A meritorious service medal was awarded to Mr. J. E. Cooke, of Manchester. Mr. D. H. Wood was elected Junior Vice-President.

The post-Congress tour was better patronised than was expected and 100 persons (mainly from overseas) participated.

Sir Robert Hadfield, F.R.S., and Mr. Harry Brearley were presented with the honorary freedom of the City of Sheffield.

During the Congress a meeting of the International Committee of Foundry Technical Associations elected Mr. Jean Lobstein, of Paris, as President to succeed Dr. Guido Vanzetti.

The results of a very successful competition for apprentice moulders organised by the Sheffield Branch of the Institute of British Foundrymen were announced.

The new laboratories of the British Non-ferrous Metals Research Association were opened by the Rt. Hon. Oliver Stanley, President of the Board of Trade.

Twenty-seven new members were admitted to membership of the Institute of British Foundrymen.

Mr. W. B. Lake, J.P., the President of the Institute of British Foundrymen, was entertained to dinner by the 750 workmen employed by his firm to mark the occasion of his 70th birthday.

July

Mr. J. E. Hurst received the honorary degree of Doctor of Metallurgy of Sheffield University. Dr. Hurst is a past-president of the Institute of British Foundrymen.

The 7th annual meeting of the Meehanite Research Institute was held in Birmingham under the Presidency of Mr. Oliver Smalley, O.B.E. Over 40 technical Papers were presented and three works were visited.

Mr. George Tinker won the Institute of British Foundrymen's Golf Competition held at Brockton Hall.

The announcement of a merger between Stewarts and Lloyds and the Stanton Ironworks was made.

The new steelworks at Haulbowline, County Cork, went into production.

Prof. J. H. Andrew, D.Sc., was nominated President of the Institute of Vitreous Enamellers.

August

A.R.P. for factory workers became law. No less than 80,326 professional specialists were enrolled on the Central Register.

Steel helmets were placed on sale.

Dr. Joseph Ward, J.P., chairman of T. W. Ward, Limited, presented a painting of himself, by Ernest Moore, to his co-directors to be hung in the board room.

September

War was declared by Britain and France upon Hitlerism.

The Engineering and Marine Exhibition was postponed until the war is finished.

Control of prices of foundry raw materials and products was established.

Priority of Work Order was issued by the Ministry of Supply.

Mr. Ashley S. Ward was elected Master Cutler of Sheffield.

Mr. C. W. Bigg, past-president of the Institute of British Foundrymen, was appointed Controller of Grey Iron Castings.

Publication was made of a Report of the Cast Iron Sub-Committee of the Institute of British Foundrymen on "The Properties of Grey Cast Iron."

October

Mr. John Craig, C.B.E., was nominated President of the Iron and Steel Institute.

Commander Sir Charles Craven received intimation that he was to receive the honorary freedom of the City of Newcastle-upon-Tyne.

The death was recorded of Mr. Oscar Harmer, director of Alfred Herbert, Limited, of Coventry.

Mr. L. Tavernor was appointed Professor of Metallurgy at the Witwatersrand University.

Forty new members were elected by the Council of the Institute of British Foundrymen held in Birmingham.

November

A national campaign for the collection of iron and steel scrap was launched.

Orders totalling £296,000 were placed in the United Kingdom by the South African Railway Administration.

Lord Austin was elected President of the British Cast Iron Research Association.

Lt.-Col. the Hon. R. M. Preston, D.S.O., was nominated President of the Institute of Metals.

The Control revised the prices of iron and steel scrap.

Mr. Arthur Phillips received the R. A. Jones medal awarded by the Lancashire Branch of the Institute of British Foundrymen.

Mr. F. J. Cook addressed the opening meeting of the London Branch of the Institute of British Foundrymen.

December

The death was recorded of Mr. J. E. Fletcher, the well-known foundry metallurgist.

The 1st Report of the Joint Committee on Vitreous Enamelling was published.

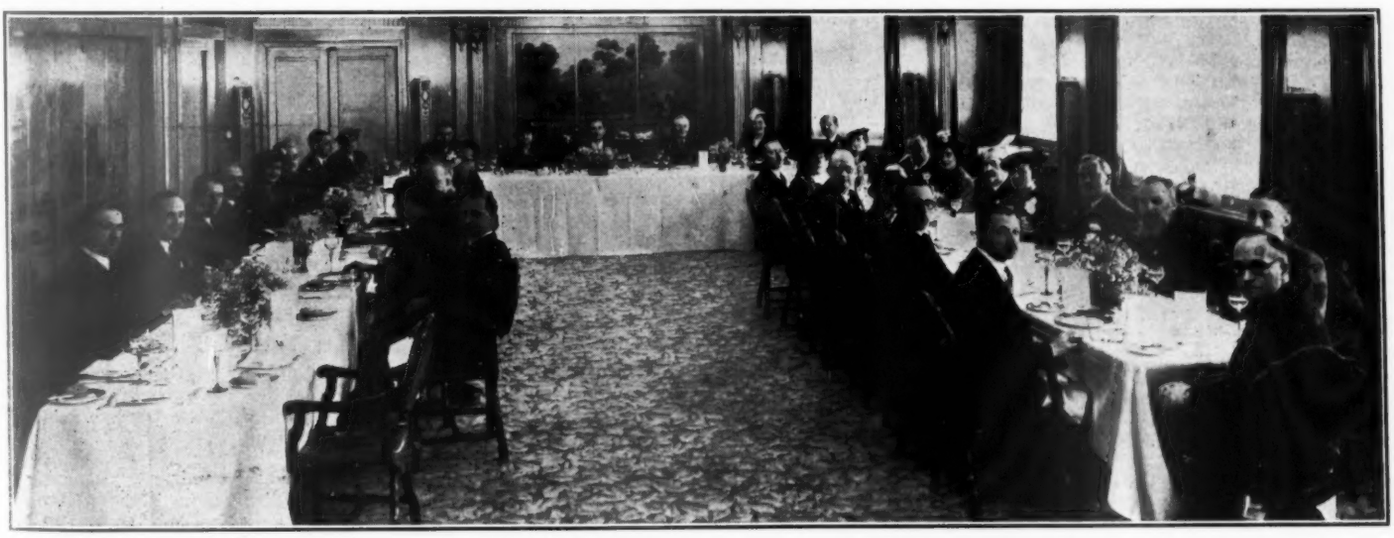
Mr. George Scotland retired from managerial duties with the Falkirk Iron Company.

Willenhall foundry workers received an increase in wages.

The reservation ages for foundry workers were lowered.

The death of Mr. R. S. MacPherran, the internationally-known metallurgist, was recorded.

The Ironfounders' National Committee, over which Mr. V. Jobson presides, issued its aims.



IN JUNE, DURING THE LONDON CONGRESS, MEMBERS OF THE INTERNATIONAL COMMITTEE OF FOUNDRY TECHNICAL ASSOCIATIONS AND THEIR LADIES WERE ENTERTAINED TO LUNCHEON BY DR. GUIDO VANZETTI (ITALY), PRESIDENT OF THE COMMITTEE. REPRESENTATIVES OF NINE NATIONS WERE PRESENT. WHEN WILL THEY NEXT ASSEMBLE TOGETHER?

How American Foundries Fared Last Year

By OLIVER SMALLEY, O.B.E. (H.M. Consul, Pittsburgh)

IN 1929 the Department of Commerce reported 3,915 grey iron foundries operating in the United States. Penton reported 3,426 in June, 1937, and the Grey Iron Founders' Society report 2,963 operating to-day. At first blush, this indicates a dying industry, but actually the tonnage of castings made in 1937 exceeded that made in 1929, and 1939 shows a further increase in the consumption of grey-iron castings. The year 1939 also records a good operating year for both steel and malleable castings despite a shorter working week, higher minimum wages, increased cost of supplies, and closer selling prices. Technically no outstanding advance can be recorded for the year.

The American Foundrymen's Association held its annual convention in Cincinnati, Ohio, and despite the absence of an equipment exhibition, it attracted greater attention than any previous meeting of that organisation devoted entirely to the technical and practical phases of the industry. Official greetings of the Institute of British Foundrymen, the British Cast Iron Research Association, the Iron and Steel Institute, and the Staffordshire Iron and Steel Institute were conveyed by Dr. J. E. Hurst, whose popularity in the United States is almost as great as it is in Britain.

Topics discussed in the various lectures included:—

Grey Cast Iron.—The Value of the Microscope to the Foundryman and Fundamentals of Physical Grey Iron Metallurgy, Alloy High-Test Cast Iron, etc.

Steel.—High Alloy Steel Castings; Improved Machining Properties and Improved Heat Treatment.

Malleable.—Effect of Manganese on Second Stage Graphitisation, Hydrogen in Solid White Cast Iron and Atmosphere for Malleable Iron Annealing. Atmospheric control is proved to effect certain slight economical advantages. Its first essential is that it be non-scaling.

General.—Moulding Sand, Shop Courses, Apprentice Training, Materials Handling, Safety and Hygiene, Time Study, Foundry Costs and Patternmaking were all given suitable consideration.

Grey-Iron Castings

In the field of grey cast iron one cannot record any outstanding progress. The grey-iron industry has been fully occupied in coping with a full order-book and trying to make a little profit to create a reserve which has not been possible in the past several years.

The Grey Iron Founders' Society has continued its struggle for existence. It is still difficult to convince many in the industry of the need of an employers' association. The leaders feel that an organisation serving a similar purpose to the British Cast Iron Research Association is urgently necessary to the technical progress of the industry, and although little has been accomplished in this direction it has succeeded in issuing a useful practical contribution on the "Engineering Properties of Grey Cast Iron"—a 55-page critical bibliography of the technical literature.

The main work of the Society this year has been confined to studies of such subjects as "Wage, Hour, and Working Conditions," which attempts to take the "guess" out of wage and hour discussions, "Standard Sales Agreement and Trade Customs," "Physical Specification Sales," "Cost Accounting," "Free Employment Service," and "Trend of Business Report," etc.

The Society, being the only association which is national in scope, is recognised as the only mouthpiece of the grey iron industry by the Federal Government, and is frequently consulted by it on such subjects as the wage and hour law, national labour relations, interstate commerce commission, and society security, etc.

Steel Castings

The steel casting industry has continued to show considerable interest in technical and operating conditions during the past twelve months. This has largely resulted from the collective study given to these problems by the leading operating men of the industry during monthly group conferences under the auspices of the Steel Founders' Society. Studies on the usual subjects of melting practice, slag control, sands, chills, cleaning room practice, safety and hygiene have been considered.

Some further advance seems to have been made in the adoption of radiography as a means of better inspection. During the year, some foundries have taken up radiography in a routine manner.

MR. OLIVER SMALLEY, O.B.E.

The year 1939 has seen an increase in the use of cast-weld construction in an effort to reduce the cost of an all-welded fabrication. Also complicated castings that are difficult to produce integrally are being considered from the standpoint of manufacturing them in readily castable parts, and assembling the composite structure by welding. Improved accounting, advertising, better selling methods, better profits, labour and public relations and foundry operating efficiency are subjects that seem to have received paramount attention.

Malleable Cast Iron

The malleable foundry industry is required to produce castings having certain minimum requirements as to tensile, ductility, impact strength, machinability, etc., and deliver them at the time required, and at a competitive price. The relative importance of the various physical properties among themselves and in relation to delivery time and cost naturally varies with different applications.

Since the several requirements are not altogether compatible the American Society for Testing Materials has recognised three grades of malleable differing in tensile and elongation.

Railways regard high ductility and strength as the principal requirement and prefer Grade 35018 of the American Society for Testing Materials' specification. The motor vehicle industry finding this specification impracticable for foundry reasons prefers the slightly less ductile 32510 grade. Manufacturers of pipe fittings, to whom soundness and machinability are of major importance, have almost standardised on the weaker cupola malleable. This subdivision into a reasonable number of grades, each adapted to a specific purpose, represents one of the most useful developments in the industry.

In the so-called pearlitic and alloy malleable, the American Society for Testing Materials has been able to develop only a descriptive form of specification which does not include any designation of properties. Since the materials have usually been developed each for a particular purpose the possible combinations of properties found on the market are legion. It has been found relatively recently that the graphitising and other heat-treating methods of the malleable industry are applicable to alloys which should be classified as steels and a whole family of graphitisable steels seems likely to come into being.

Short Cycle Annealing

A limit seems to have become recognised in the industry of the advantages of reducing the annealing time. Shortened cycles do not necessarily mean economy and it is claimed that it is quite possible to operate orthodox ovens on an annealing cycle of 90 hours. An increased investment may reduce this to 70 hours or less but at a much increased capital outlay. It appears that faster annealing cycles than 70 hours are difficult to justify. A faster time could be obtained but users will not pay the increased price for faster delivery. Further decreases of time can be accomplished by the adoption of special processing of the metal by the addition of minute quantities of tellurium to an ordinary low-phosphorus grey iron of suitable composition, which will render it white (British Patent No. 510,757); such a treated white iron may be malleablised by annealing at 900 to 985 deg C. for six to twelve hours, according to the nature of the iron and properties required. However, this cannot be considered as anything but an innovation.

In conclusion, 1939 has added little to the already known fundamental knowledge of metallurgy and foundry practice but has added much to its commercial expansion.

Future Prospects

This year ushers in a decade which promises to be far different in its initial stages from that of the 1930s. The nation has just experienced the sharpest war-stimulated recovery period on record, whereas 1930 witnessed the initial stages of a business recession which developed into the great secondary post-World War depression.

America anticipates a bitter war and the chances are good that she will not participate in hostilities during the coming year. American interests will be diverted in 1940 to domestic problems involving politics, public spending, and private enterprise, and it is hoped that domestic recovery can go ahead despite the war. Busi-

(*Concluded on page* 45.)

Poland's Foundry Industry in 1939

By ADAM HARASOWSKI (Former Assistant Manager of the Trzyniec Foundry, Poland)

THE foundry industry of the Polish Republic developed in a very enlightened manner following the country's recovery of its independence, and occupied one of the leading places in the national economy. The industry not only supplied the needs of the home market, but also exported to many other countries.

In those last twenty years of Polish independence, technical knowledge concerning the properties and uses of cast iron and other metals and alloys had greatly increased, as is evidenced by the extremely great development of steel castings, the better qualities of cast and malleable cast iron, high-tensile bronzes, centrifugal castings, new methods of dealing with small castings and cores, etc.

In that period, also, much valuable matter relating to the scientific aspects of founding has been published. Some of the names of the foundry research workers, such as Mr. K. Gierdziejewski, Professor at the Warsaw University, or the late J. Buzek, Professor at the Cracow Mining Academy (who died shortly before the recent outbreak of hostilities), are well known in all civilised countries in both hemispheres.

Conditions Prior to Invasion

For several years machine moulding as an aid to increased output has been practised in very many Polish foundries, the quality of the products being thought equal or superior to hand moulding, whilst the output was increased at a considerable reduction of cost. Besides all sorts of hand presses and squeezers, there were in use various types of power machines designed to ram the mould and to separate it from the patterns, actuated mostly by compressed air. Sand mixing and preparing machines, mechanical conveyors and other up-to-date installations were also in use, chiefly in the newly created industrial district, the so-called "Centralny Okreg Przemyslowy"—The Central Industrial District—(C.O.P. for short), but there were also, of course, innumerable old-fashioned or even antiquated foundries, still competing successfully with the modern ones.

Most of these out-of-date foundries, being of small capacity, had the advantage of personal contact between the owner and workmen, due to the constant personal supervision. Another point in their favour was the comparatively small overhead charges, especially as regards the obsolescence of plant, and the interest on capital invested, which in many cases was negligible.

MR. ADAM HARASOWSKI

How the Older Foundries Compete

It has been a rule usually observed in most Polish foundries that the production of good castings at an economical cost demands good equipment, but however necessary good tools, machines, furnaces, etc., may be, they become useless if associated with bad management. As foundry management is largely a human question, not one of the various stages followed in production can be neglected; each stage must be given its full share of attention. For instance, the foundry chemist ought to possess a good knowledge of furnace operation and of moulding, whilst the foundryman should have a knowledge of the metals he handles. It ought to be remembered, also, that however anxious the man in the shop might be to test his work by the cost of its production, low production costs do not necessarily imply economical foundry practice. If, for example, a slight increase in foundry costs results in a larger decrease in machining costs, it obviously contributes towards economy. A low cost of production in the foundry should not be at the expense of a high finishing cost in the machine shop. In this respect it may be stated that several of the older foundries, managed by good "heads," were successfully competing with some up-to-date plants.

Export Business

A staple item of Polish export trade for many years past up to the present war was comprised of cast-iron pipes for sewers, gas and steam systems, railway cylinders, containers for fluids, gases and vapours, sanitary castings, bath tubs and hollow ware, ironmongery, including enamelled ware, etc., known the world over for the high quality and low prices. These goods were sent to 86 countries in Europe, North Africa, Asia Minor, China and South America. The high absorption capacity of the home market retarded the full development of export in these lines; in spite of that, Polish castings could compete abroad as regards quality and price with the most highly industrialised countries in the world.

As it became obvious in March, 1939, that a war between Poland and Germany appeared to be imminent, all the 10 or so largest foundries in Poland, as well as some of the smaller plants, were put under military control and the nature of their products changed to conform with the needs of the Polish army. The smaller foundries had to make such castings as are required for hand grenades; shells; bombs; caterpillar parts for tanks and gears to operate the caterpillars; machine-gun stands and parts; armour plates of smaller sizes; parts of aeroplane engines and of aeroplanes themselves, cast in Silumin and other light alloys; different parts of small arms, etc. The larger foundries were casting big armour plate moulds, cupolas in cast steel for small guns and machine guns, stands and other parts of guns up to 75-mm. barrel diameter. This was done to aid the existing State Arms Factories (Panstwowe Wytwornie Uzbrojenia) in Warsaw, Radom, Skarzysko and some other places, which were unable to meet the tremendously increased demand for iron and steel castings.

Difficulties Overcome

The above-mentioned period of pre-war change of production was found by all leading Polish foundries to present great technical difficulties. Indeed, there were major obstacles to be overcome because of the necessity of adapting tools and plant to meet the new conditions. For instance, some foundries had to face the problem of casting heavy steel castings which were originally thought beyond the lifting capabilities of the existing plant. An example of one of the difficulties overcome at the Trzyniec Foundry was the lifting by means of a 25-ton jib-crane of a 45-ton gun turret by raising it one end at a time and pushing underneath a specially designed device, after which the other end was lifted and an old railway platform was inserted. The casting was then pushed into an annealing oven on this iron platform for heat-treatment. Here further difficulties were encoun-

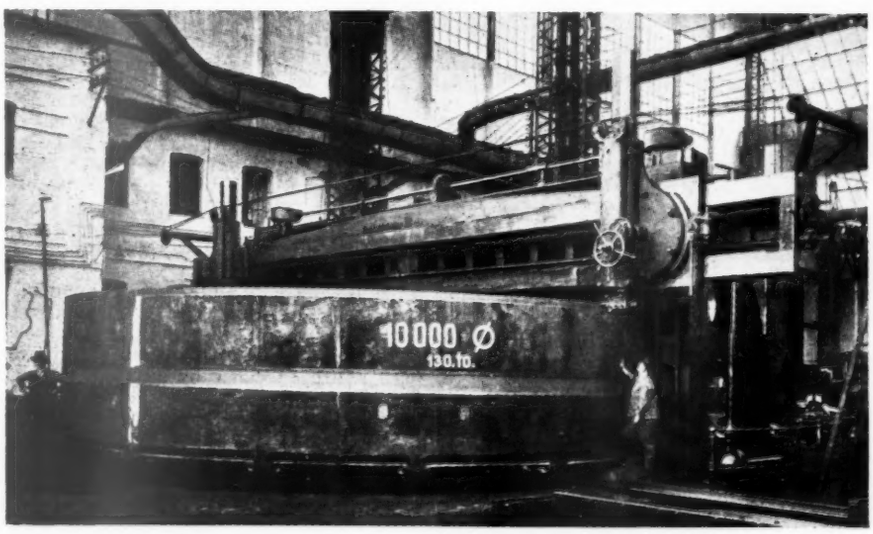


FIG. 1.—A 130-TON CASTING MADE BY THE HUTA ZGODA, POLAND.

tered owing to the fact that the oven was too small for such a big casting and part of the gun turret was protruding. After this had been overcome by means of an additional refractory brick construction, there was further trouble in cutting off the heads of the casting, as all the mechanical saws were too small for this job. The task was accomplished by a combination of mechanical saws and oxygen cutting, and these turrets were cast afterwards at the rate of one turret a day in that particular foundry without further difficulties.

This example is quoted to illustrate the obstacles which had to be overcome. It required much time and patience to convert speedily from peacetime production to wartime munitions, especially when one considers that the output required by the army was increased 30 times or even more. An early appreciation of this fact may contribute towards victory—and may British foundries remember it!

Increasing Output

It is quite natural that any figures applying to the output of castings of any of the foundries for the Polish army were concealed under the cloak of secrecy. The author regrets also that, owing to the present distressing circumstances in Poland, he is unable to give exact figures referring to the total output of foundry industry in 1939. The figures given in Table I were taken mostly from the abbreviated Warsaw Annual of Statistics for 1937 and 1938 (" Maly Rocznik Statystyczny," Watszawa). Some of the figures were published elsewhere. It has to be remembered that the output of castings delivered directly to the military authorities was not allowed to be published, and consequently does not appear in the figures quoted.

TABLE I.—*Metal Outputs, and Production Figures for the Polish Metallurgical Industries.*

	1937.	1938.	First six months, 1939.
	Tons.	Tons.	Tons.
Pig-iron	730,000	879,000	622,000
Steel	1,450,000	1,738,000	954,000
Zinc	93,000	162,000	101,000
Lead	15,000	37,000	22,000
*Castings**—			
Iron	217,000	295,000	164,000
Steel	136,680	150,300	142,000
Special steel	18,614	25,200	17,500
Aluminium	1,200	3,300	unknown
Copper..	3,800	4,200	,,
Tin (bearings) ..	1,000	2,500	,,
Antimony (bearings)	2,000	2,300	,,
Antimony (for types)	1,000	1,200	,,
Zinc (for alloys) ..	9,000	13,500	,,
Type alloys	1,900	3,500	,,
No. of Furnaces in operation—			
Blast furnaces ..	16	19	22
Siemens furnaces ..	47	56	61
Cupolas	108	122	130

* Made by the ten leading concerns

All the foundries in the country were members of the Export Union of the Polish Iron & Steel Works, Limited, Katowice (" Zwiazek Eksportowy Polskich hut Zelaznych Sp. z o. o."), which carried out all general export matters in Poland and abroad as regards this trade. What follows is a description of the leading Polish foundries. Most of them were located in the Upper Silesian area.

By far the largest Polish foundry concern was the Joint Mining & Smelting Company, Limited (Wspolnota Interesow Gorniczo Hutniczych S.A., Katowice). The interests combined in the above company included five coal mines, five iron foundries, and six manufacturing plants. About 40 per cent. of the total output of steel ingots, blooms and bars were produced by this company. It employed 30,000 workmen and 3,000 office employees. Besides rolled products, the company manufactured iron castings up to 130 tons and steel castings up to 100 tons in one piece. It also produced pig-iron, steel and iron castings at the ironworks of Huta Pilsudski, Huta Batory, Huta Florian, Huta Zgoda, and Huta Zygmunt. The chief location for producing iron castings was Huta Zgoda, where the foundry was attached to a large concern for manufacturing all kinds of machines. Huta Zgoda was responsible for chilled rolls for rolling mills up to the largest sizes demanded, as well as wheels for narrow-gauge railway trucks and cars, with chilled treads and bores, requiring no machining at all. Most types of the running orders, such as wormgear boxes, bearings, pinions, steam valves, etc., were standardised and machine moulded. Stainless acid-resisting, heat-resisting castings were also made, as well as car ladles for molten metals or slags, for use in foundries, blast-furnace plants, etc.

The next largest concern in the Silesian area was the Huta Pokoj Smelting Works & Mining Company of Silesia (Huta Pokoj, Slaskie Zaklady Gorniczo Hutnicze S.A.), Katowice, employing 7,500 workmen. It manufactures pig-iron, Armco iron, steel and iron castings up to 50 tons, chilled rolls, castings for internal-combustion engine parts, balls in manganese steel for crushing machines, etc. These were all produced at Huta Pokoj in Nowy Bytom, whereas Huta Baildon in Katowice, affiliated with Huta Pokoj, was noted for high-grade steel castings, high-alloy, acid-resisting and heat-resisting castings, etc. Affiliated with the Huta Pokoj Company was a concern called Ferrum S.A. (Ferrum, Limited), Katowice, manufacturers of acid Siemens steel castings up to 20 tons weight in one piece, cast pipes up to a diameter of 13 ft. for sewers, gas and steam systems, cylinders and containers for fluids, gases and vapours, rotary ovens, and other components for the cement industry.

FIG. 2.—A NEW BLAST FURNACE AT HUTA PILSUDSKI, DESIGNED BY THE AUTHOR.

There were three more large foundries in the Silesia District—Huta Bankowa at Dabrowa Gornicza, Modrzejow Hantke at Sosnowiec, and the Tube and Iron Works of Sosnowiec. All these localities are in the neighbourhood of Katowice, quite close to the German border. The Huta Bankowa Smelting Works, Limited (the full name for which in Polish is Towarzystwo Akcyjne Zakladow Hutniczych Huta Bankowa), operated with French capital and had its registered offices in Paris, the Polish head office in Warsaw, and the works themselves at Dabrowa Gornicza. They were makers of pump castings and railway accessories.

The United Mining & Smelting Works, Modrzejow Hantke, in Sosnowiec, comprised five foundries: Milowice, Katarzyna, Staszic, Czestochowa and Blachownia, producing steel and pig-iron, and making iron and steel castings of small and medium size, as well as aluminium and bronze castings. They made also quite a number of castings for agricultural machines and implements, of which they were manufacturers. The Sosnowiec Tube & Iron Works, Limited (Towarzystwo Sosnowieckich fabryk rur i zelaza) produced, in addition to steel tubes, cast-iron radiators, central heating boilers, armour-plate moulds, and high-grade castings from electric furnaces.

The Lower Silesian Foundries

Among the leading Polish foundries of the Lower Silesian district mention must be made of the Trzyniec Foundry (the full name for which in Polish is Gorniczo-hutnicza Spolka Akcyjna Karwina Trzyniec), employing 5,000 workmen and founded in April, 1839. This plant had very modern electrically-driven rolling-mills and well-equipped blast furnaces, whereas both the steel and iron foundries were out of date. Nevertheless it produced very good steel castings up to 25 tons weight and sometimes heavier, as recounted above. Typical of its output were retorts for dynamite production, locomotive parts and wheels and all sorts of castings for munitions. Chilled rolls were the chief output of the iron foundry, but all sorts of ironmongery, steam valves and sewers were also made. The Trzyniec foundry long had a high reputation for artistic bronze castings, such as statues and bells. It was also the favourite plant of the late Prof. Jerzy Buzek in which to conduct foundry research.

Other Large Works

Among the largest foundries beyond the Silesian area are: (1) Ostrowiec Blast Furnaces and Ironworks, manufacturers of steel castings up to 80 tons, centrifugally-cast pipe, chilled rolls, etc.; (2) the Starachowice Blast Furnaces & Foundries, Limited, in Starachowice, makers of steel and iron castings up to 50 tons, guns and munitions; (3) the State Engineering Works in Warsaw (Panstwowe Zaklady Inzynierji, Warszawa), which made PolskiFiat lorries, tanks, caterpillar-tractors, etc. (these works had a very well-equipped foundry); (4) Lilpop, Rau & Loewenstein, Warsaw, locomotive and railway car manufacturers; (5) Stowarzyszenie mechanikow Polskich z Ameryki, Limited, machine-tool makers, with a well-equipped foundry in Poreba; (6) H. Cegielski, Poznan & Rzeszow Machine-Tool Manufacturing Company, Limited; (7) Metallurgical Industrial Works of Poland in Radomsko (steel castings and chilled rolls), and (8) Zieleniewski & Fitzner-Gamper, Limited, Cracow (boilers and machines, high-tensile bronzes).

Since the advent of the Germans, the larger foundries suitable for armament manufacture have been preserved and kept in operation, due chiefly to the German idea that, being situated on Polish territory, they will be immune from air raids. The better equipped ones were transferred piecemeal to Germany, which process is still taking place. The remainder had previously been destroyed either by air raids or by gunfire. The writer, who escaped from Poland during the war period in September, witnessed much of this wanton destruction during many of the 25 raids in which he was involved. This article is therefore a review of the Polish foundry industry during its recent flourishing state immediately before the invasion. One wonders how long we must wait before it is revived to its former prosperity. May it be soon!

The Latest Foundry of The Midland Electric Manufacturing Co., Ltd.

By VINCENT C. FAULKNER, F.R.S.A.

IT is probably unique in the history of the foundry industry that within the course of a decade a firm should twice make such plant changes as to render previous conditions obsolete. Such is the story of the development of the Midland Electric Manufacturing Company's enterprise. The word "obsolete" has been used in its correct sense, that is, that it is no longer in use, without signifying that the discarded plant or methods are or were inefficient. In point of fact, the first semi-mechanised installation put into commission at the Barford Street, Birmingham, works, which largely relied on the use of roller pathways, was and still is an economical means of production for certain conditions. The advantage which the management of M.E.M. Company has derived from these experiences has been the assembly of data upon which they could base the layout for the future of an ever-extending business. The second step, it will be remembered, was the more complete mechanisation of the Barford Street Foundry by the installation of a mould conveyor and automatic sand plant.

Finally, during the years 1936 and 1937, the whole factory was gradually moved from Barford Street to a 14-acre site at Tyseley, where the foundry buildings were designed specially to house a mechanised continuous casting plant, fettling shop and patternshop. In doing this the following conditions were taken into consideration:—

(1) There should be as far as possible straight-line production.

(2) The methods of fettling used produced no dust.

(3) The type of castings made, carrying a minimum of core work, created no serious dust problem at the knock-out.

(4) Because of the extension of the firm's activities the quantity production of castings involving box parts was imperative.

(5) Two plants being essential to cope with the production, it was wisely decided to make them exactly alike, so that each could tackle both boxed and boxless moulds. This gives the management elasticity in production at some slight increase of mechanical complication. The mechanical complication to which we refer is the provision side by side of two knock-out contrivances.

The Foundry Building

The general arrangement of the new shop is shown in the drawing (Fig. 1). It is worth noting that the main dimensions are 280 ft. long and 130 ft. wide. The height to the roof trusses is no less than 28 ft., and this provides a really airy well-lit shop. The walls to a height of 6 ft. are brick, surmounted by 5 ft. of glazing. Above this, Robertson R.P.M. corrugated sheeting has been used. The sheets are bitumen-coated on both sides, with an aluminium finish on the inside. The lighting is by mercury-vapour discharge lamps giving an overall illumination of 10 to 14 ft.-candles. At the moment, to comply with A.R.P. regulations, the roof lights and the upper portion of the side lights are blacked out, whilst during the night time the lower sections of the side windows are provided with three-ply board shutters. The advantage of height is quickly being reaped, for in the near future a gallery is to be built along the sides of the fettling end of the shop to house the patternmaking and certain other sections. Patternmaking is a relatively small department furnishing metal patterns for mounting on the machines.

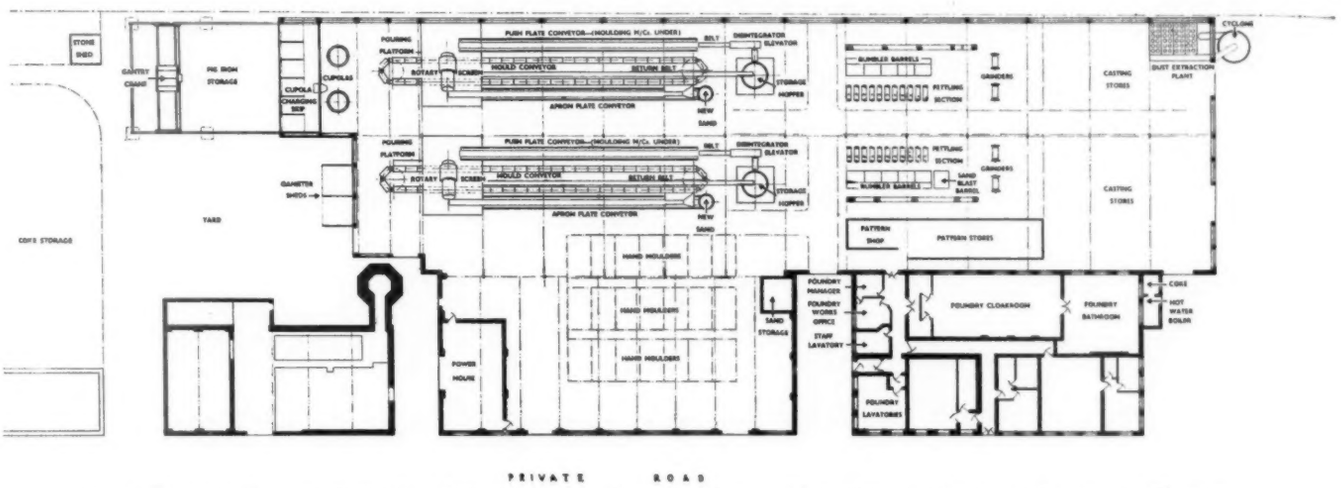


FIG. 1.—GENERAL LAYOUT OF THE NEW FOUNDRY OF THE MIDLAND ELECTRIC MANUFACTURING COMPANY, LIMITED, AT TYSELEY.

Handling Raw Materials

The site not being adjacent to the railway (Tyseley Station is about a quarter of a mile away), the handling of raw materials has been suited for the reception of material by lorry. Thus the exterior wall forming part of the sand bin carries an opening level with the base of the motor lorry so that shovelling is made easy. As the weekly consumption is only of the order of 25 tons, there is no point in installing plant for its handling. Pig-iron, scrap, coke and limestone are all dealt with by a common system, which involves the filling of open-fronted skips carrying a flange along the back of the bottom plate. By means of a floor-operated electric crane, these skips are hoisted above the level of the cupola platform, racked out and lowered so that the flange of the skip comes to rest on a railing, whilst the front sits on the edge of the appropriate bin at a lower level. This simple method enables one man to carry out single-handed all the operations of the stockyard. On the cupola stage the raw materials are weighed out into a small skip suspended from a runway, through a spring-dial weighing machine. This skip is pushed to the cupola charging hole and its contents discharged down an inclined shute into the furnace.

Melting Plant

Metal is provided by one of two brick-lined balanced-blast cupolas yielding 4.25 tons per hour, working on alternate days. The inside diameter is 33 in. and the height to the charging hole is 17 ft., the whole being surmounted by a modern spark arrester. A minimum amount of modification only has been necessary to make it completely glare-proof. The furnace is operated at 16 in. w.g. pressure delivered by a Keith Blackman fan, installed on the cupola staging centrally between the two plants. The melting process under these conditions is usually termed continuous, but actually it is intermittent, the stopping and starting being governed by the fan operating in conjunction with a syphon brick.

The metal is carried to the pouring stations or to the loose pattern floor in 50-lb. capacity single-handed monorail-suspended shanks.

Knock-outs

As the main raw material for moulding is provided by the knock-out in any automatic moulding system, it is convenient and perhaps logical to commence the description of the plant at this point. So far as the writer is aware, the system used at this plant is unique inasmuch as it deals with both boxless and boxed moulds. As will be seen from Figs. 2, 3 and 12, the first knock-out is for handling boxed moulds. It

consists of two suitably mounted compressed-air cylinders carrying pistons, the ends of which are joined by a plate. By operating the lever shown on the left, any moulds in front of the plate are pushed on to the grating of the knock-out placed directly in front of it. The grating, the bars of which are spaced with apertures of 1½ in., is jarred by the mechanical rotation of cams. The sand falls through the grating on to a 24-in. wide belt conveyor between 8-ft. centres, spilling on to the main apron conveyor coming from the second knock-out The steel boxes, which are the Sterling variety, are returned to the moulding machines by a short length of roller conveyor shown in Fig. 3.

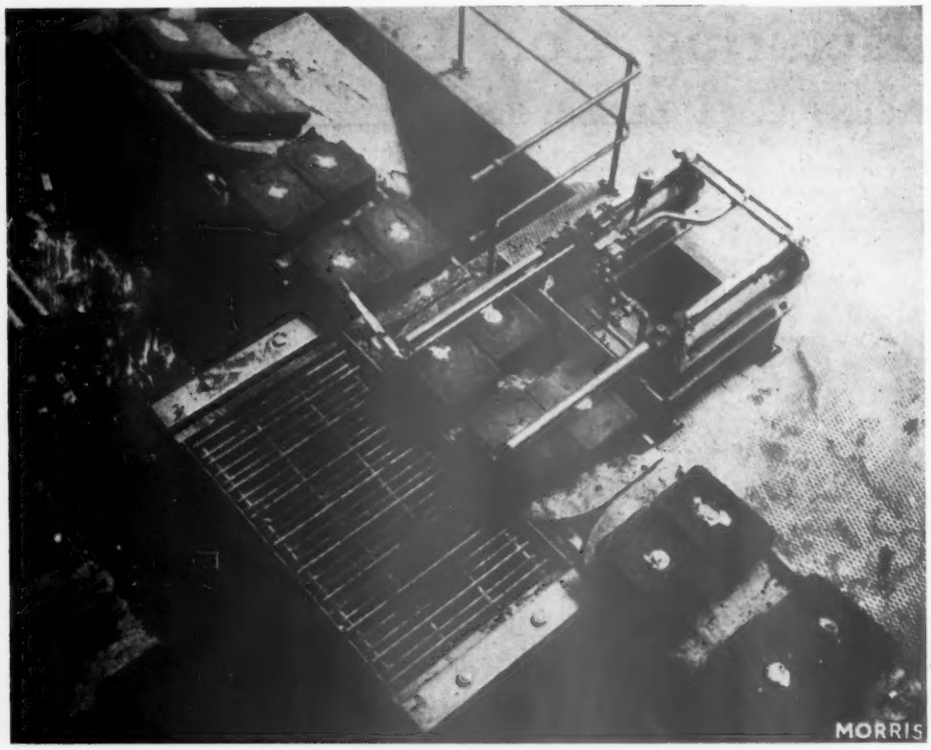


FIG. 2.—CLOSE-UP OF THE KNOCK-OUT FOR BOXED CASTINGS.

The second knock-out, for dealing with the boxless moulds, has previously been described, when the writer dealt with the second Barford Street installation. Briefly the system is that, on reaching the knock-out, the plates of the mould conveyor tilt and the cast-up moulds are pushed manually from the conveyor. The plate being flanged retains the perforated bottom plate. Since the picture shown in Fig. 3 was taken, a very useful, ingenious, yet simple modification has been introduced. As a certain amount of wastage occurred through the breakage of castings by dropping on to the apron conveyor, it was realised that a reduction could be effected if the fall could be "broken." As a consequence, about half-way down the pit, a shaft has been installed and on it there are a series of balanced prongs, the spacing being about 3 in. between each. This system has proved itself to be particularly effective. It is shown in Fig. 12, which gives a general view of the foundry.

Sand Handling

The mixture of sand and castings is carried up to a height of 30 ft. by the apron conveyor shown in Fig. 4. About 4 or 5 ft. high, there is erected at the side of the apron conveyor a small staging, where a man is stationed for picking out the castings and sliding them down an inclined plane, shown at the right-hand side of Fig. 5, where they fall on a grate-covered working table. Here a rough fettling separates

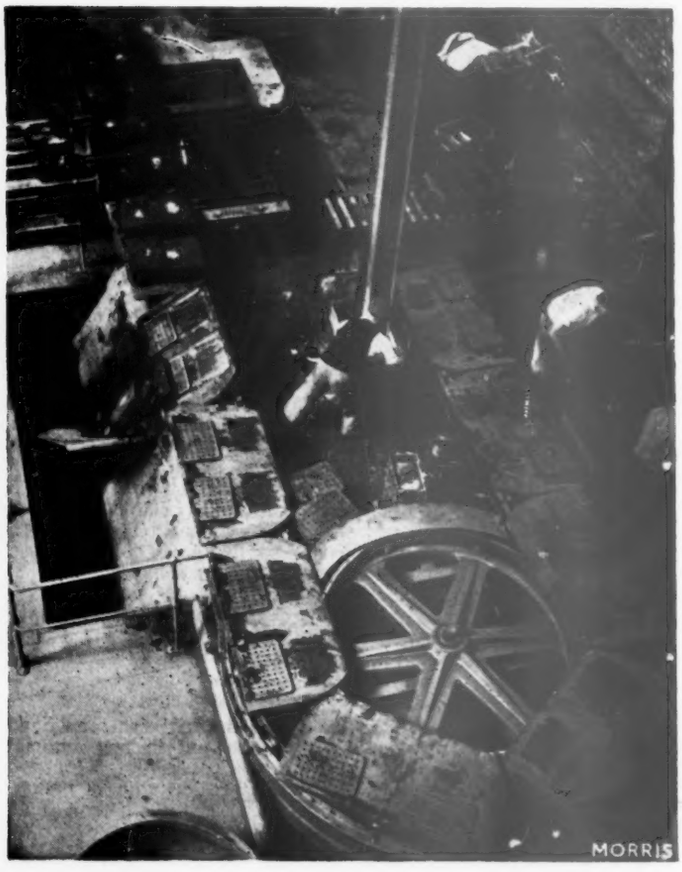


FIG. 3.—KNOCK-OUTS FOR BOXLESS AND BOXED MOULDS. THE FORMER HAS BEEN IMPROVED AS SHOWN IN FIG. 12.

FIG. 4.—GENERAL VIEW OF THE PLANT SHOWING THE APRON CONVEYOR FOR TAKING SAND AND CASTINGS FROM THE KNOCK-OUTS.

the runners from the castings and allows of the separation into crates for transport to either the stockyard or fettling department. The sand falling through the cleaning table is removed regularly.

The knocked-out sand now freed from the castings is carried by the apron conveyor to feed a 5-ft. diameter inclined rotating cylinder provided with internal vanes to break up any lumps of sands. This cylinder carries an extension in the form of a ½-in. mesh screen. All tramp iron drops from the end of the screen on to the platform and periodically this is shovelled into a shute to fill a barrow ready for transport to the stockyard. This system allows any castings which have inadvertently passed the operator to be easily retrieved. This section of the plant is shown in Fig. 5, and in more detail in Fig. 6. The hopper shown in the central foreground is for adding coal dust. It allows the coal dust to fall on to an inclined belt feeding the storage hopper to be referred to later.

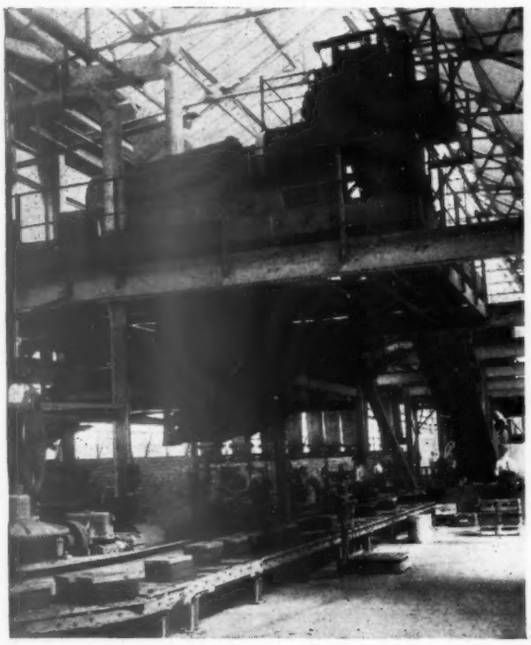


FIG. 5.—SHOWING THE PLANT FOR PRELIMINARY SAND PREPARATION, MOULDING MACHINES AND MOULD CONVEYOR.

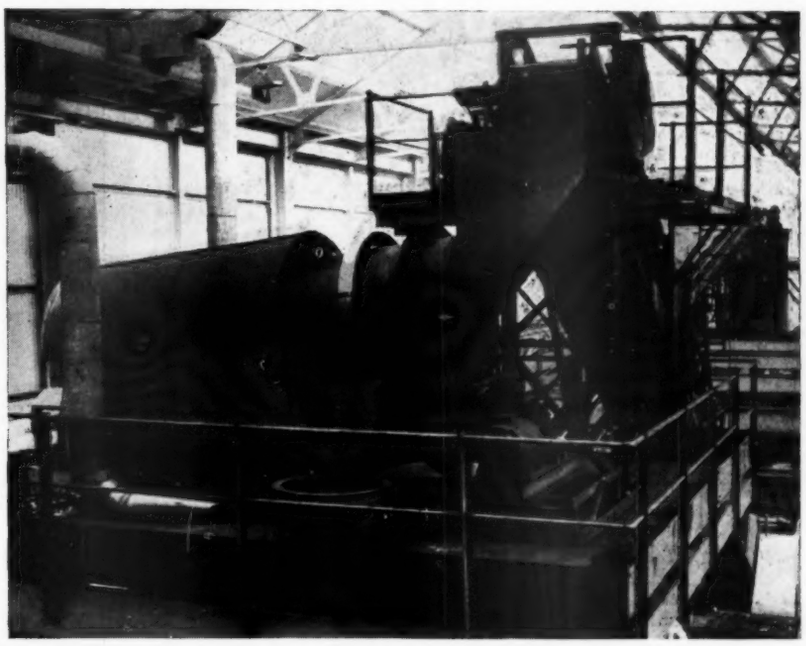


FIG. 6.—SHOWING DETAILS OF THE PLANT FOR THE INITIAL CLEANING OF THE SAND.

Sand Preparation

The sand falling through the rotary screen spills on to an 18-in. wide belt running between 15-ft. centres, which feeds an inclined belt conveyor 18 in. wide set between 100-ft. centres, which was referred to earlier and is shown in Fig. 7 as having received the coal dust. An Electro Magnets, Limited, overband magnetic separator is situated over this conveyor and removes the tramp iron. The coal dust is added to the sand just before it passes beneath the magnet. The sand is spilt into a 17-ton storage hopper, shown in Fig. 8. This hopper is slightly conical, the base being of greater diameter than the top. The bottom is formed of a rotating plate provided with a plough which feeds a continuous mill of the flat muller open-pan type. Here the moisture content of the sand is controlled by a ring of sprays.

The milled sand is ploughed off into the boot of a belt and bucket elevator running at 200 ft. per min. The buckets measure 12 in. by 6 in. and are formed from steel pressings. The conveyor is totally enclosed in steel plating, open at the top so as to give a chimney effect to aid cooling. In parenthesis, it seems desirable to emphasise that the ratio of sand to iron is so high in a plant of this character that there is a comparative freedom from troubles arising from either dust or hot sand. The elevator is driven from the top and here, too, is the belt tensioning device. Due to these factors, the sand elevator can now be said to be trouble-free provided adequate attention is given to maintenance. The buckets were remarkably free from adhering sand.

The elevator ejects the sand into a disintegrator of the rotating-cage type, consisting of an inner cage revolving at a high speed and an outer stationary one, each constructed from round steel bars. The sand is fed to the centre of the revolving cage and thrown centrifugally through the bars. After disintegration the sand falls on to an inclined short length of belt conveyor, shown in Fig. 9. From this conveyor it falls on to a scraper flight conveyor, which pushes the sand over trapdoors of progressively increasing sizes, unless a particular machine demands an extra supply, to fill the hoppers placed above each moulding machine. Should there be any surplus sand after filling all the hoppers, it falls on the short length of conveyor passing beneath the revolving screen.

The hoppers serving the moulding machines, of which there are 12 on each plant, are parallel as to two adjacent sides and tapered on the other two. They have the usual clam-shell closures. It is pleasing to record that no hammer marks are showing, and one factor to which their perfect functioning can be attributed is a weekly cleaning out.

New sand is added to the system at the lower end of the apron plate conveyor and the hopper for feeding this can just be seen in the foreground of Fig. 3. Only one type of sand is used, and that is Bromsgrove. Its properties are controlled to give 5.0 per cent. moisture; the A.F.A. green permeability number is about 40, and the green strength is 6 lbs. per sq. in., both at a ramming density of 1.5.

Moulding Plant

The 20 moulding machines of various types serving the two plants include Ronceray D.F.4 hydraulic squeezers, Foundry Equipment Company's CA.1 plain jolt squeezers, British Insulated electric squeezers, and Foundry Equipment T.2 roll-overs. Moulding is effected extremely rapidly, and personal timing showed the regular production of moulds in 35 to 40 seconds. Possibly because there is no grating for allowing spillage to be taken away by underground conveyor, the amount of sand falling on the floor is remarkably small. What does fall, however, is shovelled back on to the pattern. Running below the line of moulding machines is a trench pit lined with white tiles and lit by bulkhead lamps. This provision has been found to be well worth while in order that proper attention can be given to the hydraulic cylinders, packings, glands and so forth.

Labour and Power Requirements

Each plant requires a working staff of about two dozen men, whilst the electric power conditions are such that the 15 separate electric motors on each plant have a current consumption of the order of 75 amperes. At cardinal points around the plant are push-buttons for stopping the plant. Starting up, however, can only be effected from the switchboard shown in Fig. 10. Here is shown the series of buttons to be pushed in the sequence indicated. Compressed air for the plant is supplied at 90 lbs. per sq. in. by Broom & Wade compressors.

Fettling

Slingsby trucks are used to take the castings along the well-kept pathways to the fettling shop, where reliance is placed upon barrelling for their cleaning. The dust is extracted from beneath the barrels through culverts running under the floor to a cyclone extractor, which deposits the dust into suspended bags. The barrels are belt-driven from a single shaft. A battery of double-ended three-speed Mitchell grinders are used for the final fettling.

Welfare

The Midland Electric Manufacturing Company is noted for the excellence of its welfare organisation, and it is so extensive as to warrant an article solely devoted to its activities. Space considerations, however, will allow the

FIG. 7.—SHOWING BELT CONVEYOR TRANSPORTING CLEANED SAND TO THE PREPARATION PLANT.

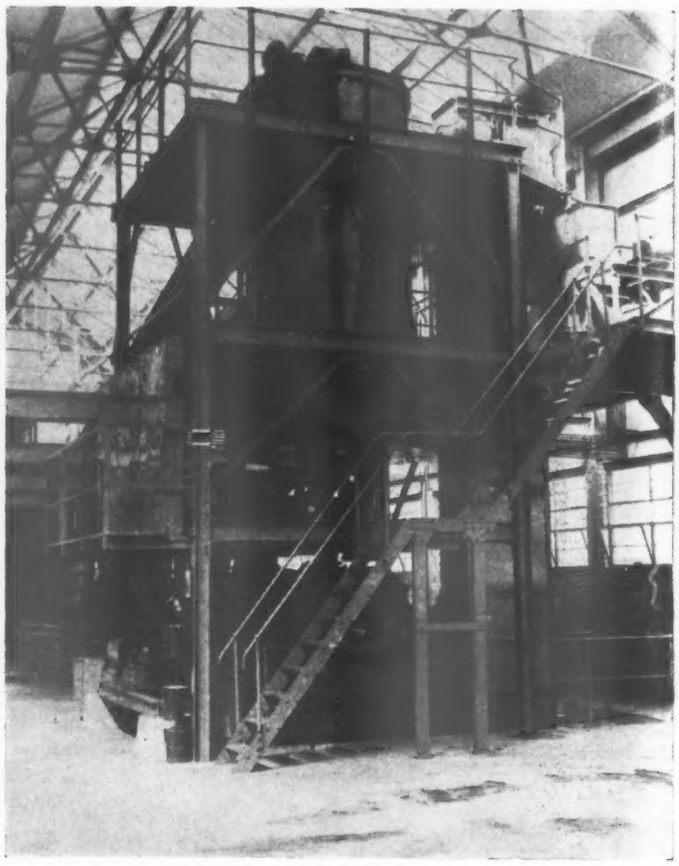


FIG. 8.—17-TON SAND STORAGE HOPPER AND THE BELT AND BUCKET SAND ELEVATOR.

FIG. 9.—PUSH PLATE CONVEYOR FEEDING THE HOPPERS ABOVE THE MOULDING MACHINES.

FIG. 10.—CONTROL PANEL FOR STARTING UP THE CONTINUOUS CASTING PLANT.

mention of only a few of its more salient and exceptional features. Great stress is laid upon safety and, despite the removal into new premises, the annual accident figures for the last three years have been progressively reduced to exceptionally low levels. The canteens, playing fields and A.R.P. provisions are alike excellent, whilst the sanitary arrangements are comparable with a West End hotel. The bathrooms for the foundry workers are shown in Fig. 11 and these are typical of the high order of the provisions made for the general hygiene of the personnel.

Conclusion

The firm of Herbert Morris, Limited, of Loughborough, have been the main contractors for the mechanised plant, and it is lamentable that A.R.P. provisions mask its fine appearance. Yet the day-time conditions are not too unsatisfactory. An excellent and simple system has been devised for the disposal of liquid metal from the cupola in case of an air raid, and the writer will give details of this to those encountering similar working conditions.

Finally, the writer wishes to acknowledge with very sincere thanks the courtesies he has received from this company, particularly the help given in the preparation of this article by Mr. A. Wynn, director, and Mr. W. J. Barber and Mr. Blythe, works superintendent and assistant works superintendent respectively.

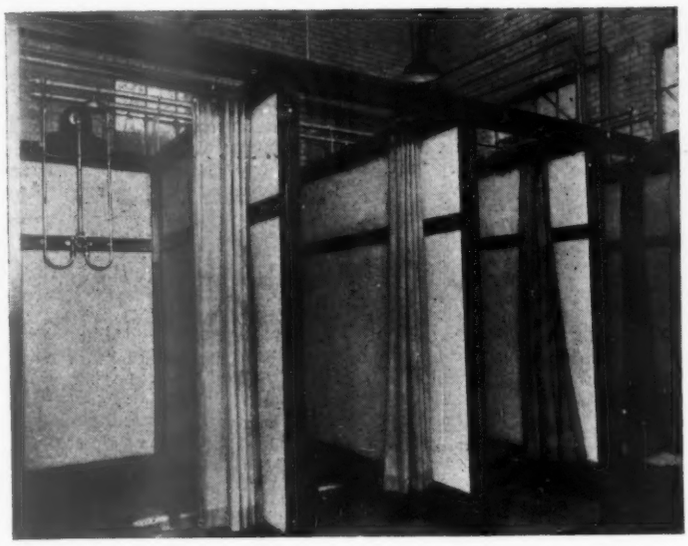


FIG. 11.—BATH ROOMS FOR THE FOUNDRY WORKERS.

FIG. 12.—GENERAL VIEW OF ONE OF THE CONTINUOUS CASTING PLANTS. NOTE THE NEW ARRANGEMENT OF THE KNOCK-OUT.

How American Foundries Fared Last Year

(*Concluded from page* 38.)

ness improvement will obviously be hindered but should not be halted by recurring national crises, unstable foreign exchange, losses in peacetime trade, and the high risk factors of a wartime economy.

The brightest spots on the horizon are the American National Defence Programme, improved outlook for utilities and railways, and the aviation and the machine-tool industries. In the last two mentioned, production is at capacity levels in many cases, and there are back logs sufficient to sustain operations at current rates well into 1940. These factors lend strong support to the upward trend of business.

On the other side of the picture, certain depressing forces are obvious besides those associated with war. These include rising labour and material costs; the threat of more employer-employee conflicts; increased taxes; business distrust of Government interference; mounting national debt; and the high degree of risk attending important nations' economic systems during wartime.

Building

Larger new contracts than those of any preceding recovery year are anticipated. Building should provide a better element of support to business in general in 1940 than it did in 1939.

Motor Vehicles

Approximately 4,000,000 units were produced for 1939. This year is anticipated to come within 10 per cent. of last year's output.

Iron and Steel Production

Iron and steel production has been running approximately 20 per cent. in excess of consumption. Operations have in recent weeks been at 85 per cent. capacity, and are at a record high on the basis of actual output. A decline to 75 per cent. or less during the forepart of 1940 would not be surprising.

Defence Programme

National defence spending at the present time at a two billion dollar a year rate will probably be increased next year. New naval appropriations, if Congress approves, will call for one and a third billion dollars to augment the Navy with three new aircraft carriers, eight cruisers, fifty-two destroyers, and thirty-two submarines, and to raise the Naval air strength to 6,000 planes.

The War Department will ask for $1,700,000,000. The rechecking of 10,000 allocated plants (plants not now used for the purpose of producing munitions and war supplies) has been placed on a one year basis instead of three years.

Larger appropriations will also be needed for the War Reserve of munitions and supplies designed to equip the Initial Protective Force (the army's name for the spearhead of trained troops and militiamen who would meet the first shock of attack on the shores of the United States). The estimated size of the Initial Protective Force has been boosted incidentally from 400,000 to 600,000 men.

Heavy Industries

National defence spending, public utility expansion, good iron and steel operations, and improved railway transportation, assure the heavy industries of good continued business equal to or better than that last year, which is cheering to the foundry industry as a whole.

At the present time the Federal Reserve Index of production is running along at little better than 120, which is 24 points above 1938 and, although the huge allied war buying boom has not materialised as anticipated, there is every encouragement of business in 1940 being within 10 per cent. one way or the other of 1939.

This would compare with an estimate of 105 for 1935, 86 for 1938, and 119 for 1929. However, to-day there is so much dynamite and uncertainty in the present situation that any forecast for 1940 contains an undue element of guess-work.

Book Review

Practical Microscopical Metallography. By R. H. Greaves, D.Sc., and H. Wrighton, B.Met. Third edition. Published by Chapman & Hall, Limited, 11, Henrietta Street, Covent Garden, London, W.C.2. Price 18s. net.

The scope of this excellent book is considerably greater than one would imagine from its title and besides being a complete textbook of practical metallurgical microscopy the structures of most important industrial metals and alloys are described and correlated with their mechanical properties and utility.

After a short introductory chapter, three chapters are devoted solely to the practical side of microscopic and macroscopic examination of metals. Practically every aspect of the subject is adequately dealt with, with the exception of the use of hollow-cone dark-ground illumination which is only mentioned. The microphotographs illustrating this section are deserving of particular mention and might with advantage be carefully studied by the majority of works' metallographers as well as by all metallurgical students.

The fifth chapter is devoted to the structure of pure metals and alloys whilst the remaining ten chapters cover the metallography and properties of the most important ferrous and non-ferrous alloys.

In general, each of these last chapters is written according to a definite system. They commence with a general introduction to the composition of the alloys under consideration. The effect of impurities and heat treatment and/or cold work upon the structure and physical properties follows and the chapters conclude with practical notes and recommendations for polishing and etching. Every chapter is profusely illustrated with typical photomicrographs of excellent quality.

This book is well produced throughout and too much emphasis cannot be laid on the refreshing clarity of the text, diagrams and photographs.

J. F. KAYSER.

Principles of Foundry Management*

By A. J. SHORE

Finance

When establishing any commercial undertaking, the aim is to make a profit. The foundry is no exception. The percentage profit is the index of success of the venture.

One often hears the expression that "you can't run a works on paper." However true that may be, it is certain that the indicator which determines finally whether a business can run at all is a piece of paper—the balance sheet.

The rather obvious fact that the *raison-d'être* of a commercial undertaking is profit has been purposely stressed, because there is a chance that foundrymen, whether metallurgists, scientists or practical men, may get so involved in the problem on hand that they fail to appreciate its financial significance.

Further, the author has suggested that the percentage profit is roughly the index of the success or efficiency of the venture because he wished to introduce the idea of indicators at an early stage. In fact, a better title perhaps would have been "Indicators as an aid to control," for indicators are a real aid to control and control is the essence of management.

Foundry Operating Report

	July 7th			July 14th			July 21st			July 28th		
	Tons	Cwts	%	Tons	Cwts	%	Tons	Cwts	%	Tons	Cwts	%
Tonnage Melt	550	17	100	534	0	100	556	0	100	544	0	100
Output	350	1	75	260	0	80	245	0	44	253	0	70
Return Scrap	69	19	15	58	4	10	10	16	2	62	12	10
Wasters	21	17	4.5	23	0	7½	21	2	4	16	8	4½
Loss in Melt	14	0	4.0	2	12	1½	15	2	4½	15	0	4½
	£	s	d	£	s	d	£	s	d	£	s	d
Output Value	400	0	3	3674	2	10	4020	1	6	4000	1	6
Wages: Production	100	1	11	1000	4	2	1107	3	1	1185	0	6
Unprod.e	299	19	2	298	15	0	322	4	8	311	2	0
Total	1400	0	2	1298	19	2	1429	7	9	1576	2	6
% Wages to Output			33 0			33 3			35 5			36 2
% Unprod. Wages to Prod.			27 2			29 6			29 0			27 7
	£	s	d	£	s	d	£	s	d	£	s	d
Consumable Stores	51	1	4	35	4	7	81	10	5	27	5	2
% to Output			1·27			91			1·96			65
Defective Work	179	19	8	200	15	6	165	8	6	176	13	7
% to Output			4·5			5·2			3·6			4·2
Overtime	20	10	6	22	6	5	35	1	3	37	1	2
% to Output			·5			·57			·87			·89
Supervision	30	1	7	30	5	6	31	2	3	30	10	8
Inspection	25	0	0	25	10	1	26	3	4	25	8	6
Clerical	19	10	6	19	10	6	19	0	0	19	10	6
Total	74	12	0	75	6	1	76	5	7	75	9	8
% to Output			1·86			1·98			1·85			1·8
Number of Operatives			450			452			448			453

FIG. 1.—SUGGESTED TYPE OF OPERATING COST REPORT.

Indicators

Consider this analogy: A well-equipped motor-car has a dashboard on which are mounted a number of meters or indicators. These meters indicate the car's performance and aid in its control. The test of a good car is the ease with which it can be controlled to meet the demands put upon it, and it is suggested this is also the test of an efficient foundry. There is no obvious dashboard in a foundry; nevertheless the elements of one should be in every foundry manager's office, if he intends to maintain effective control.

On a dashboard the more important meters indicate "rate," *i.e.*, a dimension compared with time, as the speedometer—miles travelled *per hour*; revolution-counter—revolutions of the engine *per minute*, and ammeter—quantity of electric flow *per second*, etc.

Other meters do not indicate rate, but still embody the idea of a ratio, for example, the oil pressure gauge which shows lbs. *per sq. in.* There is a third class which does not indicate a ratio at all, but rather a quantity or state, as the petrol gauge showing the available stock of petrol and the thermometer showing the temperature of the circulating water.

These indicators have their parallels in foundry practice and it is with some of them that it is proposed to deal.

One important factor must be borne in mind when considering indicators; to be effective there must be a minimum of time lag between an occurrence and its indication. For instance, a speedometer which showed only what speed a car was doing five minutes ago would be useless, and a petrol gauge still indicating a tank half-full, when it was in reality empty, would not be looked on with much favour. Likewise, considered from the point of view of control, the original example of an indicator, namely, percentage profit on a year's trading, is useless.

A Profit and Loss Account and a Balance Sheet taken together are capable of giving a true picture of the state of a business. They are usually got out at intervals of as long as a year, so the time lag between an occurrence and its inclusion in the balance sheet may be considerable. Valuable as these summaries are for determining general policy, they are practically useless as working indicators because of this time lag.

Most foundries have a record of their melt and output expressed in terms of weight. It will be recognised immediately that the mere statement of output without reference to time is valueless. Output is expressed invariably as so many tons per day, per week, or per month, as the case may be—it is, in fact, a rate.

At the outset, therefore, it is necessary to fix a period of reference; wages usually are paid by the week and a week is suggested as a convenient period for comparison for such items as output, melt, wages and materials consumed.

Weekly Cost Sheet

The first indicator then to set up is a "Weekly Cost Sheet" or "Operating Cost Report" (Fig. 1.) This is an example of its general layout, though in actual practice it would show much more detail and would be modified to suit any particular foundry's requirements. (The author's personal report has 50 items.) It will be noted that ratios are given prominence because it is on them that reliance is placed for detecting variations in the functioning of the foundry. Merely reporting figures on individual pieces of paper is insufficient.

It is essential that all relevant figures are assembled on one sheet of paper and that they are neatly arranged in columns. More important figures can be made to stand out either by the use of coloured ink or variation in spacing.

Just as one learns to tell the time by a glance at a clock, or maintain 30 m.p.h. in a built-up area, by noting almost unconsciously the position of the speedometer finger, so will one gain a comprehensive view of the foundry activities by a swift perusal of a well-laid-out report sheet.

	Sept 9th					Sept 16th					Sept 23rd					Sept 29th					Total	%	Others
	M	T	W	T	F	M	T	W	T	F	M	T	W	T	F	M	T	W	T	F			
Sand hole	5	11	11	10	4	41	17	14	8	8	9	56	8	10	10	18	6	52	14	9	14	2	4	45	194	10·4	5
Slag hole	19	13	6	·	9	47	29	23	14	8	16	92	14	16	15	28	21	96	28	18	13	13	15	82	317	17	8
Blown	4	6	4	·	3	17	2	2	2	16	12	34	3	10	11	18	1	43	6	9	2	4	11	32	126	6·75	
Drawn	6	25	4	6	·	72	63	10		4	8	85	2	9	6	8	11	36	19	16	19	1	9	64	257	13	4
Misrun	18	11	5	15	·	49	4	21	19	13	18	74	15	21	10	27	30	103	14	13	·	6	8	41	267	14·3	3
Malformed	7	6	4	2	12	31	10	13	16	18	15	69	·	13	22	8	18	91	29	23	32	11	8	102	293	15·7	2
Cross Joint	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	6	·	6	6	·32	
Warped	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	4	·	·	·	·	·	·	4	·21	
Misplaced Core	·	·	·	8	10	18	·	11	·	2	2	15	·	·	3	1	7	11	16	·	·	8	1	25	67	3·6	
Bad Surface	·	4	·	·	·	4	3	·	3	4	6	16	·	8	6	8	6	28	·	2	·	·	28	30	78	4·2	
Broken Dresser	1	6	8	5	4	24	6	7	5	2	·	20	12	12	4	3	15	46	·	15	5	11	9	40	130	6·95	
Broken Moulder	·	7	6	1	·	14	·	2	2	·	3	7	2	4	·	·	9	15	·	12	1	4	·	17	53	2·8	
Scab	3	4	·	·	4	11	·	·	·	·	2	2	2	2	4	14	10	33	·	·	4	·	·	4	50	2·65	
Bad Core	7	·	4	·	1	12	·	·	·	·	·	·	·	·	6	4	2	13	·	·	·	·	1	1	26	1·39	
TOTAL	70	126	52	67	67	380	170	103	72	71	90	476	64	139	107	127	127	571	123	116	89	65	99	492	1868		
WEIGHT Cwts.	15	20	17	15½	12	82½	16½	17½	22½	19	18	93½	11½	10	16½	25	18	80½	15½	10½	17½	26½	9	79½	330½		

FIG. 2.—SUGGESTED WEEKLY WASTERS REPORT.

Wasters Report

Another useful indicator is a "Wasters Report" (Fig. 2). The percentage wasters, back scrap and overmetal can be incorporated in the Weekly Report sheet, but percentage scrap is not much use in itself. If scrap is to be held at a minimum, causes must be known. The report illustrated is an actual one. It is considered to be sufficiently detailed to show, say, if the sand is giving trouble; if the men are getting careless; whether box pins are wearing, or if the metal is melted badly.

If recorded figures are to have any real significance, everyone who reports scrap must use the same terms to describe the same phenomenon.

* Paper read before the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen, Mr. A. Tipper, M.Sc., presiding.

"Malformed," for instance, frequently heads the list because it is the sum of a number of things, *viz.*: parts missing, swell, holes cast solid, popped bar, hole and lump and joint flash. At first it also included "cross-joint," but later it was decided to make a separate class of "cross-joint." Cross-joint indicates plant inefficiency, whereas "Malformed" is mostly concerned with the moulder.

In the author's foundry every item of scrap over 2 cwt. is recorded separately under the following headings: Description, Weight, Moulders' Name, Order No., Date, Scrap Result, Clause, Remedy, Remarks.

The report is ordinarily kept in a drawer, but as soon as a casting is scrap the inspector notifies the foundry clerk, who takes the report out of the drawer and enters all particulars up to and including "Scrap Result," *i.e.*, what the job is, who made it, when, and why the inspector has rejected it. He then puts the report in the author's basket. Now as it is not ornamental, and associated with a dislike of "waiting attention" papers, this immediately induces action. The charge-hand is sent for and the cause dis-

SCHEDULE FOR DETERMINING AMOUNTS OF PIG IRON AND COKE TO BE ORDERED FOR ENSUING MONTH.

DATE OF MEETING /9.7.39 — No. OF DAYS TO END OF MONTH (a) 9 — No. OF DAYS NEXT MONTH (b) 18

	Tons:		No 1.	No 5.	No 2.	No 10.	46.2		TOTAL	COKE
THIS MONTH	STOCK AT DATE OF MEETING.	A	221	97	25	331	51		685	32
	PIG IRON STILL TO COME IN.	B	36	-	-	-	-		36	72
	TOTAL	A + B	257	97	25	331	51		721	92
	AVERAGE PIG IRON USED PER DAY	C	4	5½	-	7	1		17½	4
	EST. PIG IRON REQUIRED TO FINISH MONTH.	CN	36	50	-	63	9		158	24
	EST. STOCK AT END OF MONTH.	A+B−CN	215	47	25	268	42		597	56
NEXT MONTH	EST. PIG IRON REQUIRED PER DAY.	K	5	6	-	8	1		20	5
	EST. PIG IRON REQUIRED PER MONTH	KM	90	102	-	146	18		360	90
	STOCK DESIRED AT END OF MONTH.	D	100	130	30	220	10		500	100
	TOTAL	KM+D	190	232	30	366	28		860	190
	EST. STOCK OF PIG IRON AT BEGINNING OF MONTH.	A+B−CN	215	47	25	268	42		597	56
	REQUIRED TO PURCHASE.	KM+D−(A+B−CN)	−25	191	5	116	16		308	134
	RECOMMENDED PURCHASE.		-	200	-	100	20		320	160

FIG. 3.—SCHEDULE FOR CONTROLLING MONTHLY PURCHASES OF IRON AND COKE.

cussed, often visiting the scene of the "crime" and determining on a remedy. This operation has purposely been detailed because of a desire to bring out a number of ideas:

(1) Indicators are useless if unused, so they must be readily available, or, better still, attention should be drawn to them when they have anything fresh to show.

(2) Reliance must not be placed on having to go and look for information—let it be brought to the executive automatically.

Stock Control

Nowadays, considerable interest is attached to the petrol gauge of a car. As mentioned before, this indicates *quantity* and not rate. The stock card takes its place in the foundry, and it is just as important to see that there is raw material in stock as there is petrol in the tank—"another truism," certainly—but how is one to know what quantity to put into stock?

Take the case of pig-iron. The buyer, the chief chemist, and the author used to meet once a month to decide on what iron was to be bought for the next month. Roughly, the chief chemist said what sort of iron was wanted. The author said how much was likely to be used, and the buyer considered how he could meet these requests with the smallest possible outlay of cash. Pencils would be pulled out, calculations made on odd bits of paper, figures compared, and only disagreement resulted. Now these meetings frequently lasted an hour, and it became apparent that though the present stock, how much iron was on order, and the daily consumption were known, there was still plenty to be done before a true estimate of how much to purchase could be determined. The "Schedule" shown in Fig. 3 was accordingly devised. It freed the mind from the mechanical relationships of figures, and saved considerable time, reducing the meeting time to ¼ hr., and sometimes doing away with the necessity of a meeting altogether. It will be noticed that the two last lines are similar, but not the same.

"Required to purchase" is the result of the mathematical process and as such is unalterable. "Recommended purchase," on the other hand, has the human touch, it allows the buying of more of one class of iron and less of another, keeping the total the same.

Many foundrymen profess a mistrust in system, describing it as so much red tape. It is certain, however, that system of some sort is necessary. These gentlemen, who scoff, would be distinctly disconcerted if the car they were driving suddenly went into reverse when they moved the gear lever into a position usually associated with top; yet, unless a definite system be established and adhered to, it is by no means certain that an order issued will be carried out. In fact, promptness of response may be taken as a measure of management control.

Discipline is the keystone of the Army, and a modified discipline is essential in the foundry.

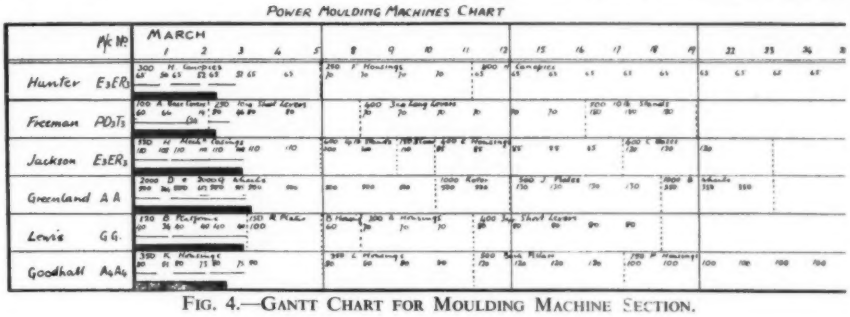


FIG. 4.—GANTT CHART FOR MOULDING MACHINE SECTION.

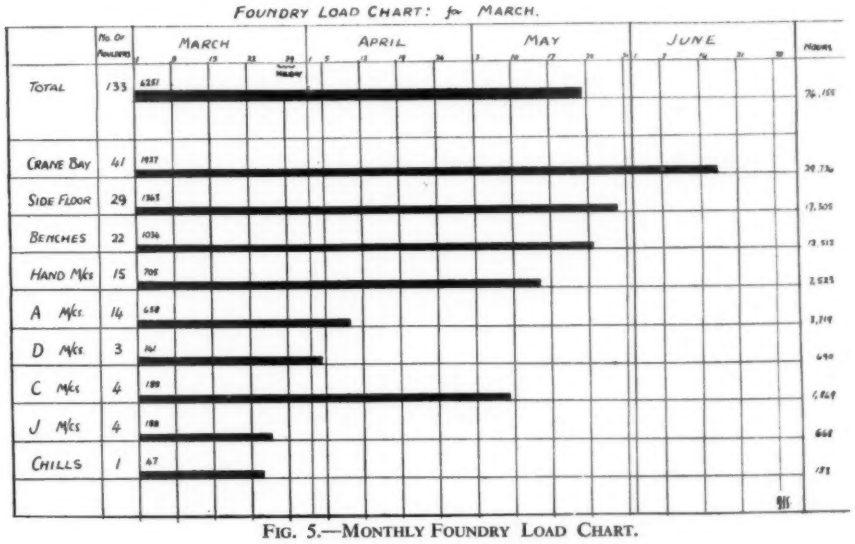


FIG. 5.—MONTHLY FOUNDRY LOAD CHART.

There are normally five classes of iron in use—common, siliceous, hematite, engineering, refined—though these are, of course, sub-divided and stacked in the yard according to their analyses. Suppose the formula for a mixture was 1 common, 1 siliceous and 2 engineering, yet a mixture of 2 common, 1 hematite and 1 engineering might give similar physical results.

A fall in price in hematite might make this second formula the cheaper mixture. The line "recommended purchase" will provide the elasticity necessary to accommodate changes of this sort.

The Exercise of Control

Indicators will show when to exercise control and how the control is functioning, but they have nothing to do with the means of control. For instance, suppose a car is descending a steep hill at 60 m.p.h. The transmission is broken and the brakes are burnt out. The speedometer correctly registers the speed, but provides no means of controlling it.

In a foundry, control is effected by means of orders written and verbal. For smooth working, it is essential that these orders should be unambiguous and rapidly and accurately transmitted. Some sort of system must therefore, be devised and an efficient office routine maintained. A loyal staff is of primary importance—but which men are the most useful—those who do exactly as they are told, or those who carry out the spirit of the instruction and report any variations? With some possible exceptions in the case of specialised or quantity production foundries, a certain amount of personal latitude is desirable; by this means the benefits arising from the exercise of initiative are not lost. The most difficult problem is to determine how much shall be dictated and how much left to personal initiative.

A Digression on Planning

Personal experience has been largely derived from a foundry producing a wide variety of castings which have to satisfy diverse conditions. Orders are frequently for one or two castings at a time. This sort of foundry is often described as a jobbing foundry. On the other hand, there are a number of running lines which recur at intervals of perhaps two months, when 100 or even 1,000 castings are ordered.

This, it is thought, is typical of many foundries, but it makes for a great deal of complication, if not positive muddle. Now to avoid a muddle a plan is needed, and planning is so closely associated with management that it can usefully be included as one of its functions. In

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order to be perfectly planned, a job must be done satisfactorily—

in the simplest way;
in the shortest time; and
with the least expenditure of energy.

The words "simplest," "shortest" and "least" have no determinate meaning unless the questions—

simplest of how many ways?
shortest of how many times?
least energy of how many expenditures?

are answered. These words "simplest," etc., increase in significance the greater the number of different ways that are tried.

CUPOLA TIME TABLE.

DATE 26/7/38

PLANNED

AMOUNT OF METAL REQUIRED	WB	HG	LG	SPEC	TOTAL
MORNING	—	8	4	—	12
AFTERNOON	28	9½	3	1½	42
TOTALS	28	17½	7	1½	54

ACTUAL MELT

WB	HG	LG	SPEC.	TOTAL

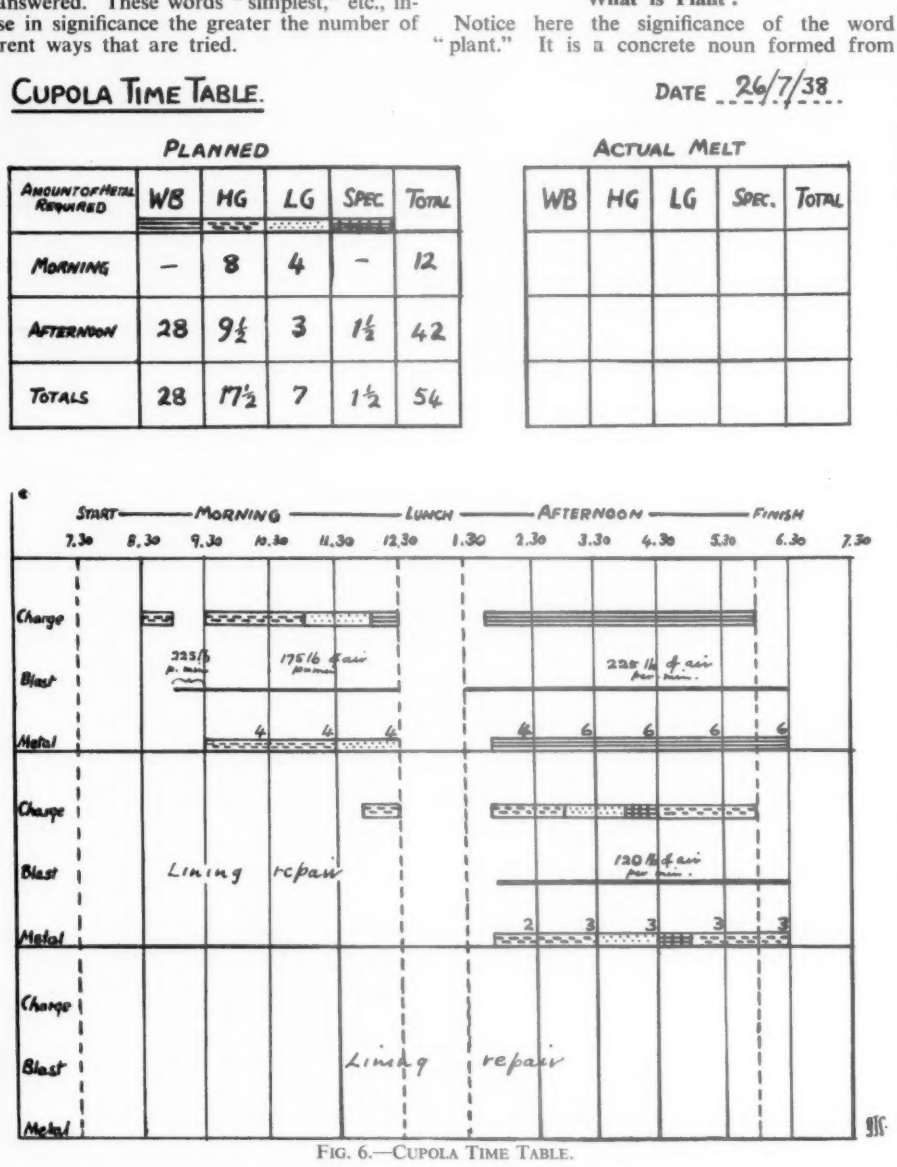


FIG. 6.—CUPOLA TIME TABLE.

This is equivalent to saying that "trial and error" will produce the perfectly planned job in the end. It also shows that "experience" is more likely to produce the perfectly planned job than inexperience.

From these conditions it appears that (1) it takes time to plan, and (2) it is impossible to plan a one-off job which is entirely dissimilar from previous experience. Actually in a foundry no job is dissimilar in all respects from every other job. However, jobs may range from being almost entirely dissimilar to identical—that is, general jobbing foundry to specialised repetition foundry.

When one component has been produced, to make a second it is necessary to perform the same operations with the same, or similar, tools in the same order. These operations have to be repeated every time a component is made. Obviously, the total time will be reduced if the number of operations is reduced. How can this be done? By making some *thing* which incorporates some of these operations.

For instance, instead of cutting the runner every time a mould is made, incorporate it as part of the plant by forming a suitable piece of metal and attaching it to the pattern, remembering, however, it takes time to make "plant" just as it takes time to plan.

What is Plant?

Notice here the significance of the word "plant." It is a concrete noun formed from the past tense of the verb "to plan." "Plant": "that which has been planned." It is useful to look on plant as so many frozen operations. The relationship of these ideas may be expressed in symbols thus:—

Let the time taken to perform operations incorporated in the plant .. .. $= t_o$
Let the time taken to make the plant .. $= t_p$
Let the number of repetitions .. .. $= r$
If S is the saving in time effected (if any),

then $S = t_o r - t_p$,

from which it will be seen that the saving in time will be greatest (*i.e.*, planning most perfect) when:—

(1) The number of operations incorporated in the plant is at a maximum.

(2) The number of repetitions is at a maximum.

(3) The time taken to prepare the plant is at a minimum.

Planning either as making "plant" or collecting information and forming a "plan" takes time. The simpler the plant (providing, of course, that it incorporates the same number of operations), the quicker it can be made, and so the more worth while it is to plan. In general, the fewer repetitions there are, the less worth while it is to plan. Further, the quicker information can be collected, the more worth while it is to plan. Records are in a way "plant"; they are a sort of "frozen experience," just as mechanical plant is, as has been shown, "frozen operations." Reference to records may reduce the number of operations in a job, and "few off" jobs will benefit from this kind of planning. The great advantage of plant is the fixing of operations—it is likewise its great disadvantage, because as soon as these operations require altering, the plant becomes useless.

The clear-minded man with manual dexterity is the exact opposite to plant. The more skilful the man, the less plant he requires, and therefore the more useful he is for the production of few-off jobs. However, the operations exist in his mind, and if he changes his mind or forgets, the job alters. Further, if the castings prove to be unsatisfactory, one cannot apply a correction until the job goes out again, and then one must remember to tell the moulder. A written plan in the form of an instruction card will help the moulder, but at best this can only be sketchy, and he may not read it anyway.

He is rather like a violinist; if he is skilful he can play a great variety of tunes. A sheet of music will aid his memory or guide him in playing a new tune. On the other hand, if there be plant available in the form of a gramophone, an unskilled operator can produce any given piece of music and repeat it *ad lib.*, provided he has the right record. The record here is "frozen" music, just as a pattern plate is "frozen" foundry operations.

This simile brings out the essential difference between a general jobbing and a mechanised repetition foundry. In the one, the manager is a sort of conductor of a band of musicians—in the other, management is chiefly concerned with devising means for producing gramophone records, keeping the gramophone in order, planning the correct sequence of tunes, and seeing that the operators put the right records on and change the needles at the right time.

The fundamental idea of control is the same in both cases, but the means employed are entirely different and this returns the subject back to the point from which the author digressed.

Extent of Control

"How much shall be controlled?" Obviously from what has been said it is evident that "How much to control" is largely a question of finance. Money and time are roughly interchangeable terms. The introduction of plant automatically stiffens control, but at the same time costs money and the formula $S = t_o r - t_p$ may show that plant is not justified. Pre-planning also may be too costly, yet there is still a powerful means of control.

A good policy is to make it easy to do a job correctly and hard to do it wrongly. That may sound so obvious that it is hardly worth mentioning; still, how often has it been found that a man has done a job the wrong way when he knew perfectly well what was the correct way? Circumstances were too much for him. For instance, he moulded a bearing bracket with the important machined face upwards, because so-and-so was using that deep top, and the manager said he wanted the casting that afternoon certain, and the moulders had already had to wait for some special facing for the lettering on the rib, and he was afraid of missing the metal if he waited any longer; moreover, he had a box at his side that would just take it, so he

thought perhaps it would not matter. The management is lucky if it finds that the job has been made the wrong way at this stage. Generally, the casting is almost completely machined before the holes are exposed, and much painful investigation follows. By now, of course, the casting in question is super urgent—it becomes the butt of everyone in the vicinity—all the jokes about sponges and pikelets are recalled; young designers suggest that it ought to be fabricated! The moulder was wrong, certainly, but he would not have gone wrong if the management had made it easier for him to go right.

No orders should be given which cannot possibly be carried out. The management ought to decide what it wants to do, determine what is possible, make its plans, issue its orders, and have a suitable indicator which will show how far these orders have been carried out.

An example of a simple system which embodies these principles is the Gantt chart. The author has been using one for a group of moulding machines for over ten years, and has found it invaluable.

Moulding Machine Chart

The chart shown in Fig. 4 is divided into vertical columns, each representing one working day and headed with the date. Horizontally it is divided into six sections, each representing a moulding machine group.

(*a*) Orders are allocated to different machines, bearing in mind the date required; the size and form of moulding box; whether it is necessary to strip or roll over or use an undersand frame: the nature of the cores, etc. The quantity of castings it is expected to make per day is written on the left-hand side of the vertical column. The expected completion of the order is marked by a vertical dotted line.

(*b*) Every morning the actual quantity made on the previous day is entered on the right-hand side of the column, and a horizontal pencil line is drawn indicating the proportion of actual work done to work estimated. A thick line is made representing the total of the pencil lines. The end of the thick line shows how far a group is in advance or arrears.

(*c*) When a machine is out of action, a gap is left in the thick line corresponding to the time the group is idle. The cause of breakdown is written in this gap.

Foundry Load Chart

Another Gantt chart is the "Foundry Load Chart" (Fig. 5). This is prepared once a month, primarily as an indicator to the works management. It entails a detailed survey of every order and a review of the activities of each man. The lines are measured in proportion to the ratio of "allowed" hours of work in any given section to the available man hours in that section. In other words, they are indicators showing when each section is likely to clear the amount of work it has on hand, which section is busiest, and how the labour is distributed.

Cupola Time Table

Another application of this type of chart is the Cupola Time Table (Fig. 6), which has proved useful in planning a melt. In passing it might be mentioned that with a combination of constant-air-weight blower and balanced-blast cupola, the same furnace is able to melt at 4 tons per hr. in the morning and 6 tons per hr. in the afternoon. This is effected by changing the blower setting and slightly altering the tuyere valves. Within the last two years the management has replaced the whole of its melting plant, and this chart was used in the early stages to establish the new routine. It has now served its purpose, and is no longer used. Mixtures are changed at approximately the same time each day, but the precise time is determined by information supplied by the charge-hand of labourers. He goes round in the afternoon to the moulders about an hour and a half before the final change of mixture and compiles an estimate of the metal still required. This total is given to the cupola charge-hand, and the number of ladles required by each section is entered on a blackboard to aid distribution.

In practice this method is superior to the chart because when laying out the chart one has to estimate *all* the metal required, whereas with the second method one only needs to estimate the *difference* from standard. The chart, however, had its use in determining the standard in the first place. A simple mechanical recorder (Fig. 7) has been rigged up by the Plant Department on the wall of the foundry office. It has been invaluable in keeping the cupola staff efficient. Before the new melting plant was installed the author could never be sure who was determining the foundry output—the moulders or the cupola men.

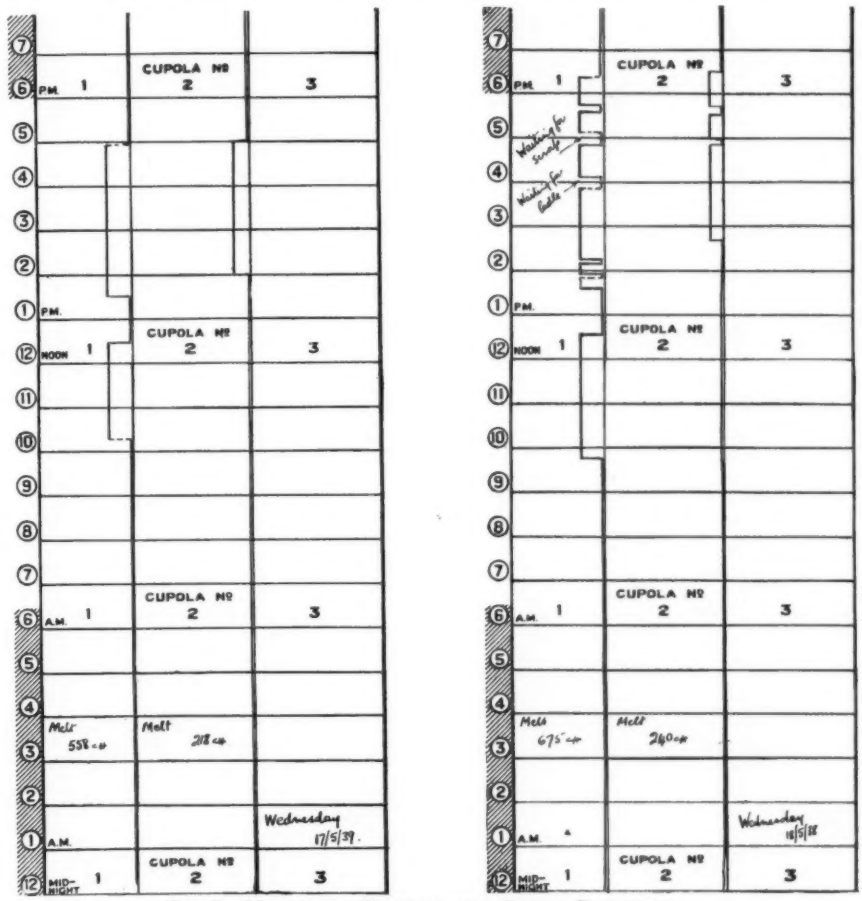


FIG. 7.—MECHANICAL RECORDER FOR CUPOLA PRODUCTION.

The moulders said they could make more castings if they got the metal when they wanted it. The cupolamen said it was no good melting any more because the moulders did not use the metal fast enough as it was.

Now, each cupola has its own constant-air-weight blower. A certain weight of air produces a definite melting rate—in other words, the weight of air is the factor which controls the pace of the chargers. A chemist sets the blower; no one else is allowed to touch it. The cupola man can only start and stop the blower; he has no control over the air once the blower has started. When the blast is off the cupola is not melting. When the blast is on the cupola is melting at a definite rate. Mercury switches are fixed to the automatic control valve of each cupola, and are connected electrically with the recorder.

As soon as the air is being delivered at the correct rate, the valve moves, the switch opens and the pen is deflected. The recorder is worked by a.c. and gives out a slight hum, which ceases, of course, as soon as the air is cut off and the pen returns to normal. In the early days as soon as the hum stopped, the author used to hurry to the cupola and ask why it was not working. He usually found they were waiting for scrap, or so and so was just putting on the top part of a mould so they had not got the big ladle back yet. If the cupola man had been allowed to alter the air to his liking, the management would never have found out these delays; perhaps the cupola would have been blamed for melting only five tons per hour when it was rated at six.

The obvious aim of the constant-air-weight installation, including recorder, is to economise melting of iron, but its real value lies in its contribution to the shortening of the working day by showing up avoidable delays—thereby keeping overheads and expensive overtime to a minimum.

It is surprising how many cupolamen, crane-drivers, labourers and the like, are kept hanging about if one moulder is late putting a top on to his mould.

Day Workers' Board

The proportioning of unproductive to productive labour is one of the major problems of foundry management. To aid in its solution, a "Day Workers' Board" (Fig. 8) has been devised.

This board is divided into a number of vertical columns formed of slots into which cards can be put. Every day-worker is represented on the board and allocated to a specific section: his absence is indicated by turning the card upside down when his name then appears with a red line through it; enforced absence is shown by reversing the card, the word "suspended" showing. The time clerk is responsible for keeping the board up to date and in practice it can

be said that it is correct 5 min. after starting time. The charge-hand of "unproductive" labour adjusts the board when he makes any major alteration of the disposition of personnel.

The number of men required in each section to meet the foundry "load" is roughly calculated and large tacks with red leather covered heads are stuck into the board to mark these numbers. A glance at the board is sufficient to determine whether or not a preconceived plan is being adhered to.

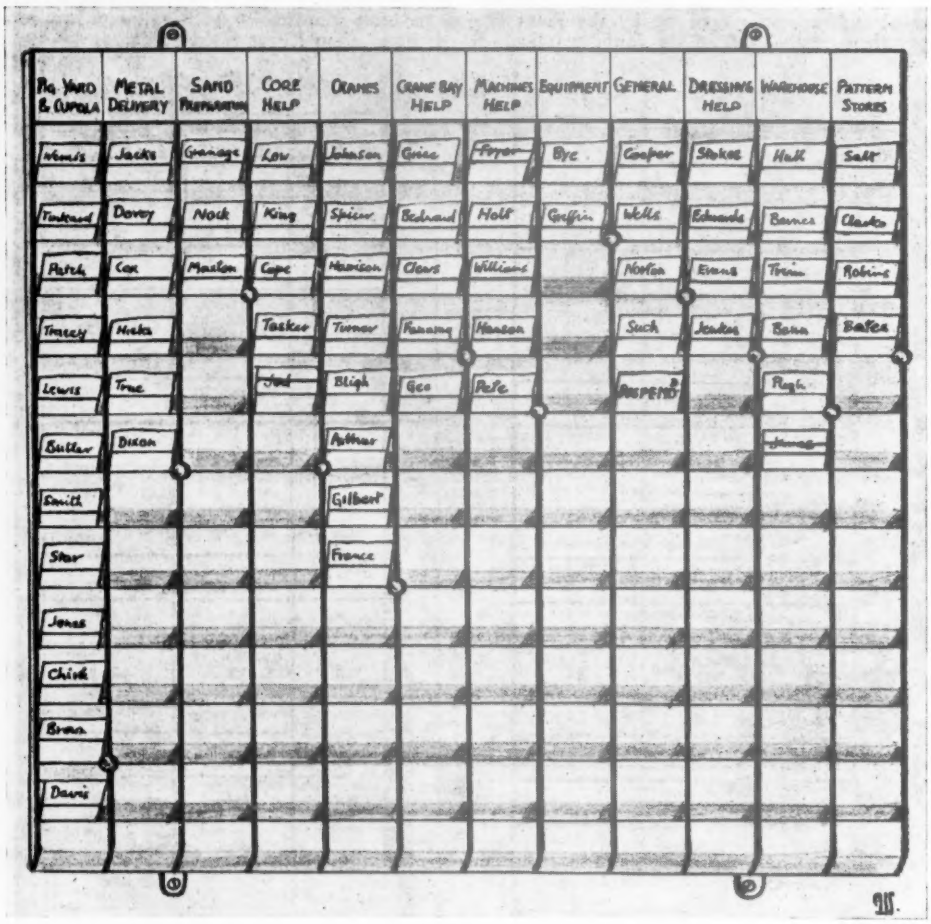


FIG. 8.—DAY WORKERS' JOB BOARD.

Core Shop Control

As a concluding example an application of management to a small shop is given. It is a core shop employing about 15 men dealing with cores ½ in. dia. by ½ in. long, wanted 1,000 at a time, to cores say 6 ft. by 4 ft. by 2 ft., wanted one at a time.

The physical layout is roughly as is sketched in Fig. 9. One pendulum conveyor takes sand to the core-makers, green cores to the stove, dried cores to storage, and returns core plates and dryer shells. There are two large batch-type stoves and one vertical continuous stove. Other plant comprises a sand mixer, a horizontal core blower and a "sausage" type machine for extruding cores. A second diagram (Fig. 10), which, for lack of a better title, has been called "Design for Core-making," refers to the same shop.

It will be seen at a glance that it is considerably more complicated than the first. It is an attempt to portray the various functional relationships, the position of control points, and the arrangement of suitable indicators.

Notice, the charge-hand is the most skilful core-maker in the shop; is a piece-worker, and earns his living like the rest.

A common error when putting a skilled operator in charge of a shop is to invest him with a certain amount of authority and then turn him into a second-rate clerk. In this case a competent clerk deals with the clerical side; he works the indicator by producing a "daily load," but has only an indirect share in control.

It is unlikely that in a shop of this size there will be enough new jobs to keep a time-study man fully occupied, but there is generally someone in the organisation who can act in this capacity when occasion requires.

In the actual shop on which this "design for core-making" is based, the function of rate-fixing and time study is exercised by a member of the Planning Department. It is largely due to his efforts and influence that the present arrangements have proved so successful.

The function of inspection is well known and needs no comment, save perhaps that *tact* is a useful adjunct. Tact is valuable in almost any occupation; it is rather like oil on a rusty lock giving freedom of movement in regions which would otherwise be barred.

Lack of space forbids a consideration of the psychological aspects of foundry management. Suffice it to say that the author is a great believer in free discussion, and holds a meeting of charge-hands each morning at 8.30.

Because some prominence has been given to charts, it should not be thought that charts can take the place of personal contact; both are valuable if used with discretion.

CONCLUSIONS

Foundry management is a subject which has long been neglected, and there have been times when the author wondered whether there was such a thing after all. Personally he believes there is, and feels that there is as great a need for research in the realm of management or that of metallurgy or mechanical engineering. Popularly "science in the foundry" is synonymous with physics and chemistry; it is supposed to radiate in some mysterious fashion from the laboratory. May not science be applied to the foundry organisation itself, rather than merely to its products? May not mathematics with the ability to disentangle relationships of constants and variables prove to be the true science for the solution of foundry problems?

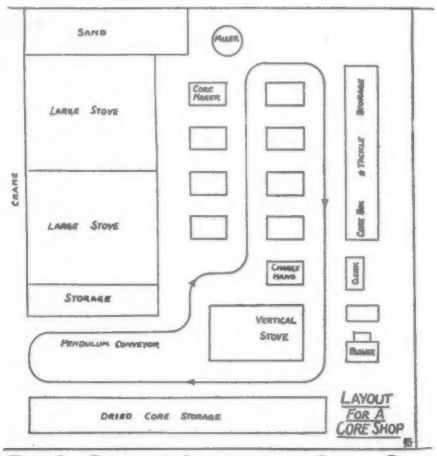


FIG. 9.—PHYSICAL LAYOUT OF A SMALL CORE SHOP.

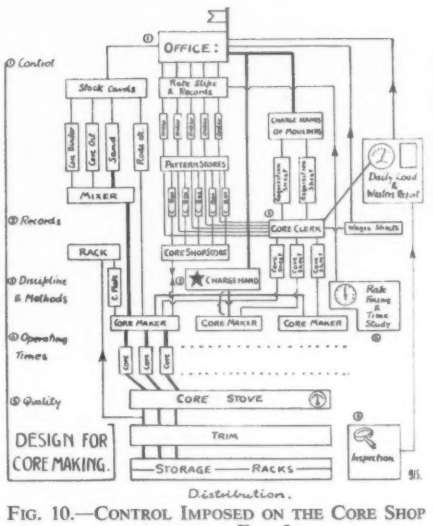


FIG. 10.—CONTROL IMPOSED ON THE CORE SHOP SHOWN IN FIG. 9.

Prof. Bragg, when speaking of atoms at the International Conference last year, said that complete uniformity of pattern caused weakness, and spoke of the strength of "organised muddle."

It is thought a parallel principle is apparent in foundry management, which means that the organisation of personal initiative is superior to the perfect uniformity of dictatorship—or, to borrow a thought from politics, a democratic system is best.

The question of "how much to control" cannot be answered generally. It must be determined for each foundry individually.

Further Note

The relationship of overheads to mechanisation is dealt with fully and a mathematical theory worked out by Erik Aug, of Sweden, in his Paper on "The Economic Limits of Mechanisation," presented to the Scientific Management Congress in 1935.

(*Concluded on page 53.*)

Types of High-Duty Cast Irons*

By A. J. NICOL SMITH, B.Sc., A.I.Mech.E. (British Cast Iron Research Association)

HIGH duty cast irons divide themselves into two classes, those which have high strength properties and those which are high duty irons in respect of some other special property, such as corrosion resistance. It is convenient to term the latter group "special irons."

High Strength Irons

Considering first the high strength irons, these can be classified into many categories according to the method of manufacture of after-treatment. This classification cannot, however be sharply defined, because any given high duty iron may be, and probably is, produced as the result of a combination of two or more of these techniques. Thus, to take an extreme case, irons are made from a high steel charge, being also alloyed, inoculated and heat-treated. Such an iron is made with the object of incorporating the strength increases possible by each of these techniques and may be classified under each of

FIG. 1.—COMMON IRON. × 200.

the processes used. It is precisely because of such overlapping that classification of high strength irons is difficult.

Until recently, the standard specification for cast iron was B.S.S. 321. This specified tensile strengths of 9 and 11 tons per sq. in. on the 1.2 in. bar, and may fairly be said to represent the traditional engineering picture of cast iron. Last year, however, the specification for high duty irons, B.S.S. 786, was introduced. This calls for strengths of 14, 17 and 20 tons per sq. in. on the 1.2 in. bar, with higher figures on the small bar and less on the larger bars. A range of standard bars is, of course, used with the object of matching the bar size with the section of the casting it represents.

This contrast of the two specifications—9 tons per sq. in. and 20 tons per sq. in.—emphasises the recent improvement in cast iron, 20 tons per sq. in. being by no means the maximum possible, and it is the object of this Paper to show how this improvement has been achieved.

Fig. 1 represents the structure of a common iron of the type giving a tensile strength of 8 to 10 tons per sq. in., and a glance at it will reveal three main reasons for its low strength. These are:—(1) The large graphite flakes, constituting planes of weakness which tend to join up into lines on the micrograph, thus extending their weakening effect; (2) the hard, brittle, phosphide eutectic, which constitutes a source of weakness; and (3) the duplex structure of ferrite and pearlite.

The removal of these defects from cast iron has been accompanied by greater technical control in the foundry and by the adoption of certain manufacturing techniques. Foundry control in its simplest form can reduce the weakening effect of the phosphide eutectic by selecting raw materials of lower phosphorus content. Technical control of a higher order is needed to reduce the inherent disadvantage of the duplex structure and to achieve an all-pearlitic structure. This is achieved by balancing the composition so that it shall give an all-pearlitic iron in the section to be cast. It is done by analytical control often assisted by chill tests, both of which need to be coupled with experience. For some castings this is comparatively simple, but there are cases where the art of obtaining the correct degree of chill calls for considerable skill from the foundryman.

One of the earliest of modern foundry techniques for the production of high duty cast iron

FIG. 2.—LANZ "PERLIT" IRON. × 200.

centred upon a means of obtaining the desirable pearlitic structure. This was the Lanz "Perlit" process, in which an iron, low in silicon, was melted in the ordinary way and poured into moulds which were preheated to between 200 and 400 deg. C. The slower cooling consequent upon a preheated mould led to markedly greater ease of getting a pearlitic structure. The pearlitic iron shown in Fig. 2 was actually made by this method. The structure is seen to be all-pearlitic, with little phosphide, though the graphite flakes are similar to those in the common iron. This improvement in the microstructure is accompanied by an increase in strength and irons of this type give 16 to 18 tons tensile. Hot-mould iron has dropped out of general use, its main defect being the difficulty of organising the foundry so that a number of moulds could be prepared to a given temperature at the same time that the metal was ready for pouring. It is still used for some special purposes, however, notably the liners of large Diesel cylinders.

Another of the early methods of producing a high strength cast iron was that due to Emmel of incorporating in the cupola charge a quantity of steel scrap. This had the effect of lowering the total carbon content and also the silicon content, but the latter was usually allowed for by the use of a high silicon pig. This reduction in carbon content, when properly carried out, enabled the production of a pearlitic iron, low in phosphorus and of good properties. This type of material became popular under the name of "semi-steel," but it should be emphasised that the material is a true cast iron. It is capable of strengths of the order of 20 to 22 tons per sq. in., but it must be emphasised that although the use of steel additions to charges is the basis of practically all modern high-duty iron, yet the addition of steel is subject to failures if used indiscriminately.

Inoculation Processes

This type of low carbon iron, besides enabling the foundryman to control the pearlitic structure, also goes some way towards control-

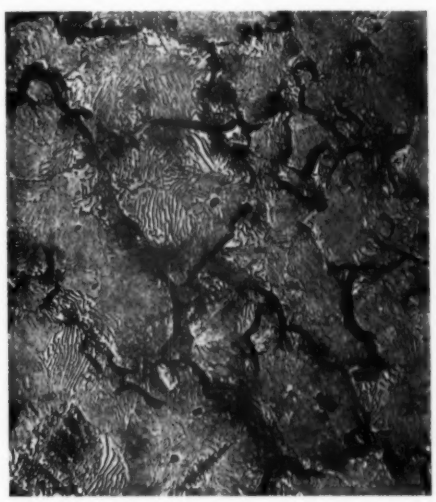


FIG. 3.—INOCULATED IRON. × 200.

ling the graphite by reducing its quantity. More positive methods of controlling graphite have been developed, however, and the most important of these commercially is the inoculation technique. The most important of the inoculating processes are those used for the production of Meehanite and Ni-Tensyl irons. The former are made with calcium silicide, while the latter are treated with nickel and ferro-silicon. Other inoculants are in use and have been developed recently. The inoculation process, besides controlling graphite size, also assists in its formation, and an inoculated iron is greyer than a material of similar composition not so treated. The strongest of the inoculated irons are, in fact, made from material which, but for the treatment, would be white. The strengths obtained by these methods are of the order of 22 to 25 tons per sq. in. A typical structure of an inoculated iron, showing small flake graphite in pearlite, is shown in Fig. 3.

A further method of controlling the graphite which has been developed in the last few years by the British Cast Iron Research Association is the production of supercooled graphite by treatment with titanium and carbon dioxide. The iron treated must contain titanium to the extent of about 0.2 per cent. This may be either naturally present, or may be added. The effect of this treatment on the microstructure

* Lecture given before the Sheffield Society of Engineers and Metallurgists.

may be seen by comparison of Figs. 4 and 5, which show a phosphoric iron in the normal state, containing flake graphite, and the corresponding material after treatment, containing supercooled graphite. This treatment can give rise to considerable strength increases. For example, a hematite iron, cast without treatment, having a transverse strength of 17 tons per sq. in., gave after treatment a transverse strength of 35 tons per sq. in.

Another feature of these fine graphite irons is their freedom from internal porosity. Fig. 6 shows the fractures of two 6-in. bars. The iron containing flake graphite will be seen to have a porous centre, while the supercooled graphite is completely sound.

Alloyed Cast Iron

Alloys in small quantities, that is amounts up to 2 or 3 per cent. which are insufficient to change the form of the matrix, can be used for improving the properties of any of the above materials. The alloys have certain common properties. They all give increased hardness either by stabilising carbides or by entering into solid solution. The alloys nickel, copper, aluminium and silicon, which go into solid solution, are capable of graphitising any free carbides in the iron and have thus a softening effect. Their total influence on the hardness is therefore the resultant of these two effects, the hardening by solid solution and the softening by graphitising free carbides. The alloys chromium, manganese, molybdenum and vanadium also enter partially into solid solution, but act as carbide stabilisers and tend to promote the formation of free carbides, thus giving white iron. These effects of alloys on the chill must be considered by the foundryman when adjusting the rest of the composition to give a pearlitic structure.

FIG. 4.—STRUCTURE OF IRON BEFORE TREATMENT WITH Ti AND CO_2. × 200.

FIG. 5.—STRUCTURE OF THE IRON SHOWN IN FIG. 4 AFTER TREATMENT WITH Ti AND CO_2. × 200.

It should be pointed out here that hardness caused by elements in solid solution has little effect on machinability, but that hardness caused by hard particles of carbide may lead to considerable difficulty in machining.

The alloys nickel, molybdenum and manganese, and to a lesser extent copper and chromium, have considerable influence on the critical point of the iron, thus reducing the mass effect and facilitating heat-treatment. Nickel and copper have but little influence on the strength or impact values of cast iron when simply added in small quantities, but since their graphitising action enables a reduction in silicon to be effected they give considerable improvement if due regard is paid to a balanced composition. Chromium has the effect of giving a small strength increase, but usually tends slightly to decrease the impact value. Molybdenum gives almost, without exception, marked increases in strength and impact value.

The use of two or more alloys in combination tends to bring out the good effects of each, and often enables the foundryman to balance his addition with respect to chill so as not to alter the chilling properties of the original mixture.

Another method of controlling graphite wholly different from those so far discussed is to cast white iron and produce the graphite or temper carbon by subsequent heat-treatment. Malleable iron of this type has been made for years by "rule of thumb," but recently there has been much work devoted to improving its properties. This includes research on alloy additions and on subsequent heat-treatment of the material. The highest strengths obtainable from cast irons are given by low carbon, alloyed, heat-treated malleable irons. An example of this class of material is the Ford crankshaft and a further example which has given strengths greater than 60 tons per sq. in. is the iron developed by Mr. W. West, of Leyland Motors, Limited*, the microstructure of which is shown in Fig. 7.

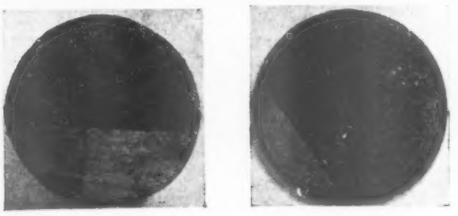
Special Irons

The austenitic irons are the most important class of special irons. In the cooling of cast iron from the liquid state, the material is deposited as austenite and normally changes at the critical point to pearlite, which may be mixed with ferrite or carbide. The addition of certain alloys is capable, however, of suppressing this critical change so that the material is austenitic when cold. This may be done by the use of 20 per cent. of nickel, part of which may be replaced by manganese or chromium, their use being limited by their tendency to form carbides. Part of the nickel may also be replaced by copper, a ratio of two parts nickel to one part copper being in common use. These irons possess medium tensile strengths of 13 to 17 tons per sq. in.; they have increased ductility and higher impact values compared with normal grey irons. Their hardness is of the order of 140 to 160 Brinell or higher with higher chromium content. They are non-magnetic and their physical properties differ somewhat from those of grey iron. They have, for example, higher electrical resistance, higher thermal expansion and lower thermal conductivity. As at present produced, they may be classified in four groups: (*a*) Nomag, containing 11 per cent. nickel and 5.5 per cent. manganese; (*b*) Ni-Resist, containing 14 per cent. nickel, 7 per cent. copper and 2 to 4 per cent. chromium; (*c*) Nicrosilal, containing 5.5 per cent. silicon, 20 per cent. nickel and 2 to 4 per cent. chromium; (*d*) special austenitic irons, containing 35 per cent. nickel for low thermal expansion.

The austenitic irons have extremely good corrosion- and heat-resisting properties which are partly attributable to their high alloy contents and partly to their austenitic condition. Not only have these irons high resistance to scaling on heating, but they also have high resistance to growth. Growth of cast iron is caused partly by carbide break-down and partly by internal oxidation along the graphite flakes. These troubles are greatly accentuated by anomalous expansions occurring at the critical point. The austenitic irons, having no critical point, show great resistance to growth.

Martensitic Irons

The normal break-down of austenite giving pearlite may be suppressed by the addition of increasing quantities of alloys giving a range of products—pearlite, sorbite, troostite and martensite—according to the quantity of alloy and the rate of cooling. The martensitic irons, which are usually produced commercially by the addition of 4½ per cent. nickel and 1½ per cent. chromium, are extremely hard and have been used in many wear-resisting applications. The grey martensitic irons have been less successful than the martensitic white irons, which can be produced with hardnesses of 650 to 700 Brinell and find many applications in rolling, grinding and crushing machinery.



FIGS. 6A AND 6B.—FRACTURE OF TWO 6-IN. BARS BEFORE AND AFTER TREATMENT.

High-Silicon Irons

Irons with silicon contents of the order of 5 per cent. to 6 per cent. have considerable heat-resistance. The silicon raises the critical point, thus increasing the range of temperatures which may safely be used and the silico-ferrite has considerable resistance to scaling. Irons with much greater silicon content, of the order of 13 to 18 per cent., have extremely good acid-resisting properties. They are however, very brittle, unmachinable except by grinding and are difficult to manufacture.

High-Chromium Irons

Irons containing up to 35 per cent. chromium have been developed in recent years. They have very good heat-resisting and also corrosion-resisting properties. Their structure consists of chromiferous ferrite containing chromium carbide, as shown in Fig. 8. Their mechanical properties vary considerably with their total carbon content. With total carbons of the order of 3 per cent., these irons are extremely difficult to machine and rather brittle, but with lower carbon content they become better from these points of view, though more difficult to cast.

High-Aluminium Irons

The use of high aluminium contents in cast irons has until recently given trouble by reason of the tendency of the aluminium to oxidise and form skins of oxide in the casting. The improved technique recently developed, however, ensures comparative freedom from this trouble

* First Report of the Research Committee on High Duty Cast Irons for General Engineering Purposes, Appendix I. Proc.I.M.E. Vol. 140, 1938, p. 224.

and high aluminium irons can now be made with excellent mechanical properties. They are found to be extremely heat-resisting, especially in oxidising or sulphurous atmospheres.

The only other class of special irons which need be mentioned are those used for nitriding, which contain 1½ per cent. to 2 per cent. of aluminium and a similar quantity of chromium.

After-Treatment of Cast Iron

The annealing of cast iron for stress relief and for softening is well known and has not undergone much recent change. The heat-treatment of cast iron by hardening and tempering has recently come to the fore and is now practised on a considerable scale. Recent work has thrown considerable light on the variation of combined carbon content with heat-treatment temperature and this enabled the vagaries in the properties of the quenched material to be understood and controlled. Heat-treatment of this type applied to suitable irons can give a 50 per cent. improvement in tensile properties. Heat-treatments of this type are also used purely for increasing hardness and wear-resistance. Hardnesses of the order of 500 Brinell are produced. It is not always necessary to heat-treat the whole of the specimen and local or surface hardening treatments are now in general adoption for crankshafts, camshafts, lathe beds and other machine tool parts. The influence of alloys in facilitating heat-treatment has already been mentioned and finds particular application in local hardening.

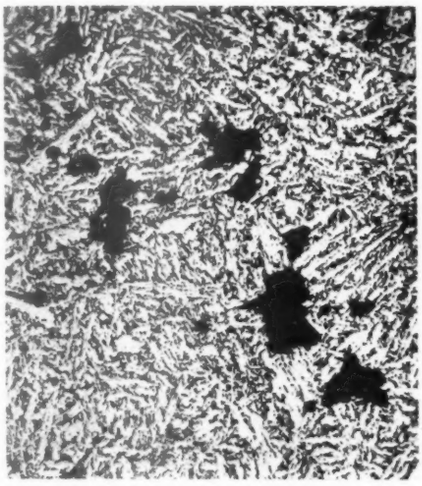


FIG. 7.—LOW-CARBON, ALLOYED, TREATED IRON GIVING 60 TONS PER SQ. IN. × 200.

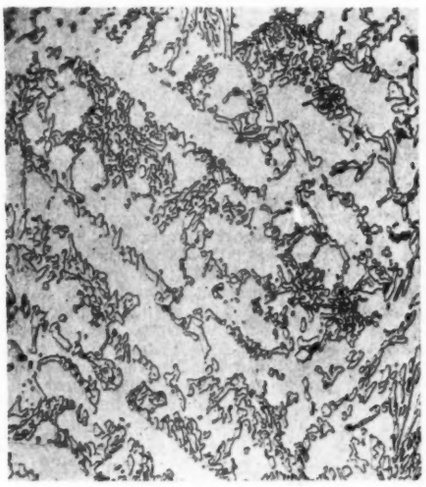


FIG. 8.—STRUCTURE OF 35 PER CENT. CR IRON. × 200.

Properties of Cast Iron

Hardness.—Cast iron shows variation in hardness with cooling rate. Thick and thin sections differ in hardness and hardness varies across a thick section. Cast irons show this variation rather more than most cast materials, because not only does the grain size vary, but the combined carbon content may also be affected. The use of alloys, however, minimises the variations, since they harden thick sections and may graphitise thin ones. They reduce the mass effect, and hence give uniformity. Graphite control also gives very good uniformity and modern grey cast iron is now no worse than other cast materials from this point of view.

Tensile Strength.—Cast iron shows very little elongation or reduction of area except in soft malleable irons. The short time tensile at elevated temperatures shows a slight increase up to 450 deg. C. and then falls. There is very little information available on the creep stress characteristics of cast iron.

Compression Strength. — The compression strength of cast iron is considerably greater than the tensile value, and varies from 40 to 70 tons per sq. in., being about four times the tensile value for common irons and three times the tensile value for high quality irons.

Transverse Strength.—The transverse strength of cast iron has been used as an indication of its quality for a long time, partly because it is an easy test to carry out. The transverse rupture stress follows the ultimate tensile stress, but the relationship is not exact. $\frac{\text{TRS}}{\text{UTS}}$ decreases with increasing quality of material from 2 to 1.6. The deflection in transverse is used as an index of ductility.

Elastic Modulus.—Cast iron is plastic at low loads, owing to the stress concentrations induced by the presence of graphite flakes. It has, therefore, no exact elastic limit or yield point. The value of the modulus of elasticity varies from 9 to 22 millions of lbs. per sq. in. It varies with the tensile strength of the material, but the relationship is not exact. White iron gives an E value of 23 to 27 million lbs. per sq. in. and malleable iron of 23 to 25 million lbs. per sq. in.

Founders' Forum

Q.—What is the principal factor causing variation in Izod impact value in steel castings of similar composition produced in the converter and open-hearth furnace?

A.—The impact value of converter steel tends to be more variable than that produced from the open-hearth furnace. This is primarily due to the tendency for overheating and the difficulty of obtaining close temperature control in the former process. The much longer melting period in the open-hearth furnace enables the steelmaker readily to tap at a suitable temperature which will impart an equiaxial grained structure to castings. Such a structure is usually coincident with satisfactory impact test values. In converter practice steel is produced so rapidly that at times overheating is difficult to avoid, and if metal is poured too hot, the resultant castings will have a dendritic structure which gives lower impact values.

Q.—How can stickiness on pattern plates be prevented?

A.—One oz of sweet oil (rape or colza) to 1 quart of paraffin provides a wash which is said to be eminently satisfactory.

Principles of Foundry Management

(*Concluded from page 50.*)

The investigation is based on the formula

$$x = at + bt.$$

Where x = the cost of converting material into finished product.

t = the working time,

a = the wages per hour,

b = the burden per hour, *i.e.*, such overheads as interest and amortisation, repairs, tools, power, light, rent, etc.

The fundamental idea of mechanisation is to attain by increased mechanisation a saving in working time. The time t is thus conditioned by b, or, mathematically, a function of b—

$$t = f(b)$$

$$x = a.f(b) + b.f(b).$$

The author goes on to discuss the question "at what degree of mechanisation (and wages corresponding to this) will manufacturing costs be the lowest?" and concludes with, "For the present the old law 'Thou shalt eat thy bread in the sweat of thy face' still applies." The author cannot quote that law in the original Hebrew, but in the language of the mathematics it is $\varphi(b) > 2$.

DISCUSSION

In calling upon Mr. E. C. Dickinson and Mr. T. H. Gameson to propose and second a vote of thanks to Mr. Shore, the CHAIRMAN remarked that after listening to the Paper he was convinced that foundry management was a definite science of which Mr. Shore had given an extraordinarily lucid account.

The proposition having been heartily received, MR. G. R. SHOTTON opened the discussion by questioning the validity of the equation $S = t_0 r - t_p$, on the ground that it did not take into account overhead charges. Regarding his analysis of wasters, the table did not give the distribution of wasters amongst moulders, etc. Detailed reports on each of the men against the distinct types of scrap were necessary.

MR. N. C. BLYTHE also commented on the lack of overhead charges in connection with Mr. Shore's equation.

MR. SHORE said that Mr. Blythe and Mr. Shotton had questioned the validity of the equation $S = t_0 r - t_p$ on the ground that it did not take into account overhead charges. It was admitted that it did not. The equation was not intended to be used as a general formula for determining the cost of a job. It was introduced merely as a summary of personal ideas—it was none the less true. No greater claim was made for it than that it clarified one aspect of the "nature" of plant.

The CHAIRMAN remarked that, as far as the science of foundry management was concerned, he was learning a great deal. He began to realise that foundries were not places where, as he once gained the impression, a man strolled in at a certain hour in the morning, set to work to make a casting, and got it through during the day or the week, but that the whole thing was planned. Success in a foundry could not be achieved without the use of science and thought.

In reply to Mr. J. Gardom, MR. SHORE emphasised that the problem in a foundry oftentimes was to find some constants in a sea of variables. When their relationships had been sorted out, they were helpful in making decisions.

In conclusion, MR. TIPPER announced that the next meeting of the Branch would be held in February. The attendance that night was encouraging, and he felt they were serving a useful purpose in continuing such meetings.

This Weeks' News in Brief

Trade Talk

THE DIRECTORS of International Combustion, Limited, Derby, have made a grant of two National Savings Certificates to all employees over 18 years, and to those under that age, one certificate.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED, Loughborough, have designed and are quantity-producing the Brush-Koela Duo Draught gas producer for attachment to road vehicles.

MR. R. A. BARING-GOULD, of 70, Victoria Street, London, S.W.1, has acquired a licence for exploiting in Great Britain the permanent-mould (continuous-casting) process developed by the Eaton Erb Manufacturing Company, of Detroit.

MEMBERS OF THE Institute of British Foundrymen are invited to attend a meeting of the Institute of Fuel on January 25, when a Paper on "Pool Grades of Fuel, Diesel and Gas Oils and their Applications" will be given by Mr. Norman L. Hudson and Mr. R. J. Bressey. The meeting will be held in the Lecture Theatre of the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, at 2.15 p.m. Members of the Institute of British Foundrymen who intend to be present may obtain advance copies of the Paper on application to Mr. T. Makemson, Secretary of the Institute, St. John Street Chambers, Deansgate, Manchester, 3.

THE international Ferro-Silicon Syndicate, with headquarters at Vienna and to which Germany, Sweden, Norway, Denmark and Switzerland belonged, was dissolved at the end of the year. The need for the continued existence of the Syndicate has been questioned for some time, and extensions of the agreement have as a result been for short periods only during the past few years. Various members of the Syndicate had criticised the price policy of the Syndicate, and had endeavoured to obtain their freedom of action again. The high prices quoted by the Syndicate also favoured the operations of outside makers in various countries, which caused just those disturbances to the market which the Syndicate sought to eliminate. The outbreak of war intensified dissatisfaction with the organisation and accelerated its dissolution, which will now apparently be followed by the formation of national syndicates to rule out domestic competition in the various producing countries. Home production in these countries will hence increase. Germany already covers nearly 50 per cent. of its ferro-silicon requirements from home sources.

Patent Specifications Published

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

514,832. SOC. ANON. DES HAUTS-FOURNEAUX DE LA CHIERS. Apparatus for the determination of the resistance to fracture of test pieces under impact loads.

514,894. DANIELS, F. C. T. Method of making ferrous alloys containing chromium.

514,941. SPARLING, W. J. Cast-iron alloy, and method of producing same.

514,950. WESTBERG, S. Production of low-carbon iron or steel.

514,951. DANIELS, F. C. T. Manufacture of grey cast iron.

514,952. CARBORUNDUM COMPANY, LIMITED (Carborundum Company). Manufacture of cast iron.

514,978. SACHTLEBEN AKT.-GES. FÜR BERGBAU UND CHEMISCHE INDUSTRIE. Production of low-carbon iron.

514,994. ROBERTSON, N. D. G., and LEWIS, E. C. Melting and casting of metals.

515,004. BOCHUMER VEREIN FÜR GUSSSTAHLFABRIKATION AKT.-GES. Method of surface hardening articles of steel.

515,103. WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY. Electric drives and control systems for rolling-mills.

Personal

MR. E. R. CLARKE, senior director of G. A. Harvey & Company (London), Limited, Greenwich Metal Works, London, S.E.7, who has completed 50 years of service with the company, was presented

MR. E. R. CLARKE.

with a canteen of silver at a complimentary dinner given recently at the Dorchester Hotel in his honour. He joined the firm as a boy in 1889 and became a director when it was made a limited liability company in 1914.

MR. A. BOYES, Hon. Secretary of the Lancashire Branch of the Institute of British Foundrymen, has changed his private address to "Roseville," 7, Kirkstall Road, Davyhulme, Manchester.

SIR ANDREW DUNCAN has been appointed President of the Board of Trade, and his position as Controller of Iron and Steel has been filled by Sir Charles Wright, the deputy controller. Sir Charles held this position during the last war.

ON THE OCCASION of his silver wedding Mr. R. Taylor, founder and managing director of Muirhall Foundry, Larbert, has been presented with an inscribed silver salver from the workers. The presentation was made by Mr. W. Paterson, the oldest employee of the firm, at a social gathering.

TWO WELL-KNOWN Falkirk moulders celebrated their golden weddings last week. One is Mr. Robert Nimmo, who is employed in the Falkirk Foundry, where he started work as a boy. The other is Mr. John Logan, who retired many years ago from the Grahamston Iron Company, with whom he was employed for almost fifty years. He is now in his 81st year.

Wills

RIPLEY, P. E., of Ipswich, engineer and ironfounder, chairman of Ransomes, Sims & Jefferies, Limited £91,500

YOUNG, J. G., of Symington, Ayrshire, director of Glenfield & Kennedy, Limited, engineers, Kilmarnock ... £120,875

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Caton's Metal Production, Limited—Capital, £1,000. Subscriber: H. F. P. Caton, 77, Kenilworth Road, Coventry.

British Magnesite Corporation, Limited—Capital, £1,000. Subscriber: G. Baxter, Woodland View, Grindleford, Sheffield.

Alteg Metals, Limited—Capital £10,000. Hard metal manufacturers. Directors: E. F. O. Alton, 14, Park Lane, Sheffield; G. J. Edwards, and H. S. Garlick.

Aldersley Engineering Company, Limited—Capital £10,000. Welders, mechanical engineers, ironfounders, etc. Director: J. B. Carr, Aldersley, Tettenhall, Staffs.

Thames Bank Lift & Electrical Company, Limited, 135, Upper Thames Street, London, E.C.4—Capital, £300. Mechanical and hydraulic engineers, etc. Directors: C. Russell and F. J. Power.

Obituary

MR. E. RAMSBOTTOM, a director of James Mills & Company (Engineers), Limited, Moss Ironworks, Heywood, Lancs, died recently.

MR. JOHN LUCKETT, who was for nearly 40 years associated with Alldays & Onions, Limited, and for ten years works manager, died recently.

THE DEATH has occurred of Mr. James Howie, chief draughtsman with Glenfield & Kennedy, Limited, Kilmarnock. He was 70 years of age. He became chief draughtsman of the firm in 1915, and served in all 53 years with Glenfield & Kennedy.

MR. WILLIAM GEORGE MACPHERSON, who died in Glasgow recently, was a notable personality in the iron and steel industry of Scotland. He built up in company with the late Provost Frood, of Motherwell, the business of the Motherwell Iron & Steel Company. When he retired at the end of the war from this company, he became Glasgow representative of United Steel Companies, Limited, retiring in June of last year.

MR. WILLIAM HENRY SMITH, head of the ironfounding firm which bears his name, died at his home at Whitchurch, Salop, at the age of 86. Mr. Smith was the grandson of the founder of the firm, which was established 103 years ago. He had, in the course of his long life, served his native town and county in many capacities. A magistrate for over 40 years, he was also Chairman of the County Advisory Committee for the appointment of Justices. He was an Alderman of the Salop County Council and was for 21 years Chairman of the Salop Education Committee. At one time he also filled (gratuitously) the office of Director of Education for the county.

Company Meetings

Cannon Iron Foundries, Limited

Observing that the net profit of the year showed a considerable reduction compared with the previous results, MR. G. A. LEITCH (chairman) told shareholders of the Cannon Iron Foundries, Limited, at the annual meeting, that this was greatly regretted by the board, who felt that the profits obtained were not commensurate with the efforts made by the directors and staff. In spite of many adverse factors, the turnover exceeded that of the previous 12 months, and in the few months prior to the outbreak of war showed a marked improvement. Notwithstanding the improved turnover, some departments of the factory were not employed to full capacity throughout the year, and consequently the ratio of overhead expenses prevented the attainment of a normal profit margin. At the present time, the demand for some of the products manufactured by the company was taxing their capacity to the utmost, and the orders on the books were sufficient to ensure a good output of such lines for some months to come. The bulk of this business was either directly or indirectly for Government purposes, although it consisted of goods for which there was also a steady demand in times of peace.

R. A. Lister & Company, Limited

Presiding at the annual meeting of R. A. Lister & Company, Limited, of Dursley, Gloucestershire, MR. PERCY LISTER (chairman) reported that their factories were not only meeting an ever-increasing pressure of demand for their products from the Services, but were making what he hoped would be an ever-increasing contribution to the Exchequer and the nation's currency requirements by keeping their export trade going. As compared with the record order-book ruling a year ago, their order-book to-day was over four times greater and 50 per cent. of the orders on hand were for the export trade.

Forthcoming Event

Institute of British Foundrymen

JANUARY 13.

Scottish Branch:—"Cast Iron for Modern Engineering Applications," Paper by T. Tyrie, at Royal Technical College, Glasgow, at 3.30 p.m.

Raw Material Markets

The period set aside for holidays and annual inventories in the iron and steel industry has now expired and once again producers are concentrating on satisfying consumers' requirements. In order that this might be done more easily imported material is arriving quite freely, but a close watch is being maintained on the supply position by the Iron and Steel Control and imports are sanctioned only when the need is urgent. In the circumstances exports must necessarily be restricted, but every effort is being made to improve the foreign currency position by this means. Manufacturers' costs continue to increase and in market circles there is much conjecture regarding the future of iron and steel prices. Higher prices, it would appear, are likely, as some part of the additional overheads will have to be passed on to the buyer. Deliveries of iron and steel seem to be arriving at users' works satisfactorily in so far as consumers are able to continue to operate steadily.

Pig-Iron

MIDDLESBROUGH — Delivery specifications continue to arrive freely at ironmakers' works in this district; no direct applications for deliveries are now considered, all orders being placed through the Control authorities, which make it their duty to ensure that no consumer is allowed to be without sufficient iron to enable him to carry on. This commendable system may only be operated by a close scrutiny of users' reserves and potential requirements, but it is enough to say that the position is now more satisfactory than it was before the war. Foundries generally are quite busy and are purchasing their iron from makers outside the Cleveland area, as local producers have not yet restarted making this type of iron.

A considerable amount of potential export business in East Coast hematite is having to be neglected owing to the extent of home requirements, which, however, are being met satisfactorily. There are now few stocks left and current outputs are being fully taxed. A ready sale for any increased production is assured.

LANCASHIRE—The position of foundries in this area continues to be variable. Several light-castings makers are in need of additional orders, while the order-books of some jobbing concerns do not extend very far ahead. However, other consumers are in the market for large tonnages of iron. Hematite is being well taken up by the specialised engineers.

MIDLANDS—The needs of the concerns engaged on war work are being given first consideration, but where possible ordinary domestic users are receiving sufficient material to enable them to carry on satisfactorily. Producers no longer have the task of distributing their outputs, having been relieved of this by the Control. As a result, the supply of iron has become much more evenly distributed. Low-phosphorus iron and hematite are in strongest demand, as the light-castings industry, the chief consumer of high-phosphorus iron, is not yet working full time. Deliveries of low-phosphorus iron have improved following an increase in output, but hematite is not yet available as freely as would be desired.

SCOTLAND—The New Year holidays extended in many instances until Monday last, but there is now full activity again in this area. The opportunity has been taken to carry out essential repair work. It is yet too early to comment accurately upon the market, but signs already point to heavy consumption of iron throughout the early part of the year.

Coke

The foundry-coke market is in a very strong position. Despite the recent increase in the price of 2s. 6d. per ton, business continues to be substantial, and most producers have entered into contracts involving deliveries up to the end of the first half of the year. Supplies are good, and deliveries are coming through satisfactorily.

Steel

In wartime, of course, it is not the practice of the Government to allow the publication of industrial statistics, and so it is not expected that the steel output for last year will be divulged. In view of the fact that production for a large part of the year was at record levels, it is believed that the output in 1939 has never been surpassed, but the New Year may well return an even better steel output figure. The industry is making an excellent start and producers are doing their utmost to meet the unprecedented requirements of users. Certain grades of steel are being released in small tonnages for export; the Government is intent on developing this side of the trade, but every effort is made first to meet home needs.

Scrap

There has been no relaxation in the demand for scrap since the turn of the year, and requirements continue to be in excess of the available supply. Scrap is undoubtedly coming forward in heavier tonnages since the inauguration of the national collection campaign. With the co-operation of the National Farmers' Union, a special test survey in connection with the national campaign for the collection of scrap iron and steel has been made in Gloucestershire, and proved so successful that a similar survey is to be made of all agricultural counties. Farmers and landowners in the more remote districts are being invited to lend every assistance in their power. It is felt that much useless scrap must be lying derelict along hedgerows, in fences, barns, stables, and other outbuildings, as well as in cellars and in attics

Metals

Copper—Consumption of copper in the United Kingdom is running at a high level, especially in connection with Government contracts. It is reported that Britain is inquiring in the United States for 1,000 tons of copper shell bands made of American copper, which would appear to be an indication of the strength of the demand in this country. The American domestic market at the present time is rather dull. Consequent upon the Russian invasion of Finland, President Roosevelt imposed a moral embargo on exports to the Soviet Union; this is resulting in many fruitless inquiries on the part of Russia, which has been pressing for supplies of copper of late. It is reported that the Cie. Française de Mines de Bor, the French-owned concern with a refinery at Bor, in Yugoslavia, has entered into an agreement with the Yugoslavian Government for a part of its production to be bought by the State in dinars and the remainder to be available for free disposal by the company abroad. As from Monday last the BOR brand of electrolytic copper has been admitted to the London Metal Exchange list of standard brands.

Tin—The tin market in London has presented rather a quieter tone of late, and consumers appear to be adopting a cautious policy. This is not surprising, as the early part of the year is usually taken up largely with stocktaking activities. Satisfactory arrivals of ore are reported, while the market is likely shortly to benefit by the acquisition of considerable tonnages of tin destined for Germany.

Spelter—The Control authorities, of course, continue to be responsible for the allocation of deliveries. Primary consideration is being given to works employed on Government contracts and there is a strong demand both for high-grade and g.o.b. metal. The United States domestic market continues to be quiet.

Lead—Good tonnages of lead are being used in connection with the manufacture of armaments, but although there is little metal to spare, deliveries are satisfactory on the whole. The housebuilding industry, which was slack before the war and is now very quiet indeed, is a big consumer of lead in normal times, and it is interesting to note that efforts are being made to revive activity in the trade. It is expected, however, that other materials apart from lead will be found difficult to secure in adequate quantities.

The Charcoal-Iron Industry

Following the presentation of Mr. Gwynn Jones' Paper on "The Charcoal-Iron Industry" (see our issue of November 23 last) to the Royal Society of Arts, a communication on the subject from Mr. T. S. Ashton, M.A., of the Department of Economics, University of Manchester, has appeared in the Society's Journal. His comments, which refer to three matters dealt with in the Paper, are appended.

(1) The claims of Dud Dudley to have smelted and fined iron with coal are now generally discredited. Doubt was first thrown on these claims by the late Mr. Rollason ("The Seamy Side of Dud Dudley"); and the researches of Dr. R. A. Mott ("Dud Dudley and the Early Coal-Iron Industry," Transactions of the Newcomen Society, Vol. XV, and "History of Coke Making") have shown that the small coal of the Thick Seam of South Staffordshire, which Dudley says he used, is non-coking and could never have been employed satisfactorily in the smelting, to say nothing of the fining, of iron. Dudley was either a sheer impostor or, at best, only one of a number of early experimenters whose efforts failed. The books of the Coalbrookdale Company on the other hand, offer conclusive evidence that, in the second decade of the eighteenth century, Abraham Darby was making marketable castings of iron. This was smelted with coke made from Shropshire clod coal which had a low sulphur content, and produced a fuel close resembling charcoal.

(2) At several points in his narrative Mr. Jones writes of "coal-smelting" where clearly "coke-smelting" is the correct term. Not until after Neilson's discovery of the hot blast in 1828-29, it is believed, was it possible to use raw coal in furnaces with satisfactory results.

(3) The letter from Wilkinson to the Royal Society of Arts may have been written by the celebrated John Wilkinson, but it is equally likely to have come from the pen of his father, Isaac Wilkinson. Both were living in 1761. Isaac had been an employee at Little Clifton Furnace near Workington and at Backbarrow in Lancashire: in 1744 he set up a furnace of his own at Lindale where he attempted to smelt iron with peat; and in 1753 he took a lease of Bersham Furnace, where the Lloyds and others had already smelted iron with coke. He died in 1784 (W. H. Dickinson, "John Wilkinson, Ironmaster"; A. N. Palmer, "John Wilkinson and the Old Bersham Ironworks"). There are many letters written by Isaac's more famous son, John, in the Boulton & Watt Collection in Birmingham, and inspection of the handwriting of these might provide the answer.

RAW MATERIALS—PRICE LIST

Wednesday, January 10

COPPER*

	£	s.	d.
Electrolytic	62	0	0
High-grade fire-refined ..	61	10	0
Fire-refined of not less than 99·7 per cent.	61	0	0
Do., do., 99·2 per cent. ..	60	10	0
Black hot-rolled wire rods	65	10	0

TIN

Standard cash	248	0	0
Three months	246	15	0
Settlement	248	5	0

SPELTER*

G.O.B. (foreign) (duty paid)	25	15	0
Do. (domestic)	26	10	0
"Prime Western" ..	26	10	0
Refined and electrolytic ..	27	5	0
Not less than 99·99 per cent.	28	15	0

LEAD*

Good soft pig lead (foreign) (duty paid)	25	0	0
Do., do., (Empire and domestic)	25	0	0
English	26	10	0
Sheets, home	34	10	0
Do. export, f.o.b. ..	35	0	0
Pipes, home	34	0	0
Do. export, f.o.b. ..	38	0	0
Tea lead (nom.)		—	

ALUMINIUM

Ingots	£110
Wire, 10g.	£120
Sheets	1/2½ to 1/4½
Circles, 20/24g.	1/3 to 1/4

ZINC SHEETS, &c.

Sheets, 10g. and thicker, ex works	30	12	6
Rolled zinc (boiler plates), ex works	28	12	6
Zinc oxide (Red Seal), d/d buyers' premises	21	0	0

ANTIMONY

English	95	0	0			
Continental Regulus, duty paid ..	85	0	0	to 87	10	0
Foreign, c.i.f. (nom.)	75	0	0	to 78	0	0

QUICKSILVER

Quicksilver, f.o.b. port of origin £150

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 0d.
Finished bars, 18% tungsten	3s. 10d.
Finished bars, 22% tungsten	4s. 4d.

Per lb. d/d buyers' works.

SWEDISH CHARCOAL IRON & STEEL

Pig-iron ..	£8	15	0	to £10	0	0
Bars-hammered, basis ..	£18	0	0	to £19	0	0
Bars and nail-rods, rolled, basis ..	£17	2	6	to £18	0	0
Blooms ..	£16	0	0	to £17	0	0
Keg steel ..	£27	0	0	to £30	0	0
Faggot steel	£19	0	0	to £23	0	0
Bars and rods dead soft st'l	£12	0	0	to £15	0	0

All per English ton, f.o.b. Gothenburg [subject to an exchange basis of Kr. 19.39 to £1.]

* Maximum prices per long ton delivered buyers' premises.

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.
Ferro-silicon—			
25%	15	0	0
45/50%	19	0	0
75%	28	10	0
Ferro-vanadium—			
35/50%	14/- lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free ($ basis)	4/9 lb. Mo.		
Ferro-titanium—			
20/25% carbon-free ..	10d. lb.		
Ferro-tungsten—			
80/85%	4/4 lb.		
Tungsten metal powder—			
98/99%	4/5½ lb.		
Ferro-chrome—			
2/4% car.	—		
4/6% car.	38	10	0
6/8% car.	36	10	0
8/10% car.	36	10	0
Ferro-chrome—			
Max. 2% car.	58	0	0
Max. 1% car.	60	0	0
Max. 0.5% car... ..	—		
70% carbon-free ..	1/- lb.		
Nickel—99.5/100%	£190 to £195		
"F" nickel shot ..	£175	0	0
Ferro-cobalt, 98/99%	8/- to 9/- lb.		
Metallic chromium—			
96/98%	3/3 lb.		
Ferro-manganese—			
76/80% loose	£17 8 0	to 17	18 0
76/80% packed	£18 8 0	to 19	8 0
Metallic manganese—			
94/96% carbon-free ..	1/8 lb.		

Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.

SCRAP*

	£	s.	d.		£	s.	d.
South Wales—							
Short heavy steel, 18 in.-24 in. lengths ..	3	8		3 to	3	10	9
Heavy machinery cast iron				..	3	15	9
Ordinary heavy cast iron				..	3	10	9
Cast-iron railway chairs				..	3	15	9
Medium cast iron				..	3	7	0
Light cast iron				..	3	2	3
Middlesbrough—							
Short heavy steel	3	6		0 to	3	8	3
Heavy machinery cast iron				..	4	0	6
Ordinary heavy cast iron				..	3	18	0
Cast-iron railway chairs				..	3	18	0
Medium cast iron					3	8	3
Light cast iron				..	3	3	3
Birmingham District—							
Short heavy steel	3	3		6 to	3	8	3
Hematite ingot mould				..	5	0	0
Heavy machinery cast iron				..	4	1	0
Ordinary heavy cast iron				..	3	16	3
Cast-iron railway chairs				..	3	16	3
Medium cast iron				..	3	9	0
Light cast iron				..	3	4	0
Scotland—							
Short heavy steel	3	8		3 to	3	10	9
Heavy machinery cast iron				..	4	3	0
Ordinary heavy cast iron				..	3	18	0
Cast-iron railway chairs				..	4	3	0
Medium cast iron				..	3	6	0
Light cast iron				..	3	1	0

* Deliv red fr e to consumers' works in England and Wales. For Scotland, deliveries free to consumers' works less 3s. per ton but plus actual cost of transport or 6s. per ton, whichever is the less. All prices: Plus 2½ per cent. dealers' remuneration; 50 tons and upwards over three months, 2s. 6d. extra.

PIG-IRON*

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	111/-
,, No. 3	108/-
,, No. 4	107/-
Forge No. 4	107/-
Hematite No. 1	124/6
Hematite M/Nos.	124/-
N.W. Coast—	
Hem. M/Nos. d/d Glas. ..	124/6
,, d/d Birm.	136/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge ..	109/-
,, No. 3 fdry. ..	110/-
Northants forge	106/6
,, fdry. No. 3 ..	107/6
,, fdry. No. 1 ..	110/6
Derbyshire forge	109/-
,, fdry. No. 3 ..	110/-
,, fdry. No. 1 ..	113/-
Scotland—	
Foundry No. 1, f.o.t. ..	112/-
,, No. 3, f.o.t. ..	109/6
Cleveland No. 3, Glasgow	111/-
,, ,, Falkirk ..	108/-
Scottish hem. M/Nos. d/d	124/6
Sheffield (d/d district)—	
Derby forge	106/6
,, fdry. No. 3 ..	107/6
Lincs forge	106/6
,, fdry. No. 3	107/6
W.C. hematite	130/-
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3 ..	113/-
Staffs fdry. No. 3	113/-
Northants fdry. No. 3 ..	111/6
Cleveland fdry. No. 3 ..	113/-
Glengarnock, No. 3 ..	127/6
Clyde, No. 3	127/6
Monkland, No. 3	127/6
Eglinton, No. 3	127/6
Gartsherrie, No. 3 ..	127/6
Shotts, No. 3	127/6

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

SEMI-FINISHED STEEL

(Re-rolling Billets, Blooms and Slabs)

BASIC:			
Soft, u.t., 100-ton lots ..	8	7	6
Tested, up to 0.25% C. ..	8	12	6
Tested, 0.25 to 0.33% C...	8	15	0
Tested, 0.33 to 0.41% C...	8	17	6
Hard (0.42 to 0.60% C.)..	9	10	0
,, (0.61 to 0.85% C.)..	10	0	0
,, (0.86 to 0.99% C.).	10	10	0
,, (1% C and up) ..	11	0	0
Silico-manganese	12	2	6
Free-cutting	10	2	6
SIEMENS MARTIN ACID:			
Up to 0.25% C.	11	7	6
Case hardening	12	5	0
Silico-manganese	12	2	6

FINISHED STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel bars, sections, plates, joists and hoops is obtainable in the home trade under certain conditions.]

	£	s.	d.
Plates, ship, etc.(N.E. Coast)	11	10	6
Boiler plts. (N.E. Coast) ..	12	8	0
Chequer plts. (N.E. Coast)	13	0	6
Angles, over 4 un. ins. ..	11	8	0
Tees, over 4 un. ins. ..	12	8	0
Joists, 3 in. × 3 in. and up	11	8	0
Rounds and squares, 3 in. to 5½ in.	12	8	0
Rounds under 3 in. to ⅜ in. (untested)	12	16	0
Flats—8 in. wide and over	11	13	0
,, under 8 in. and over 5 in.	11	18	0
Rails, heavy	10	3	0
Fishplates	14	10	0
Hoops	13	11	0
Black sheets, 24 g. (4-t. lots)	16	2	6
Galv. cor. shts. (,,)	18	12	6
Galv. flat shts. (,,)	19	2	6
Galv. fencing wire, 8g. plain	20	10	0
Sheet bars	8	5	0
Tin bars	8	5	0

FINISHED IRON

CROWN IRON:			
England and Wales ..	12	15	0
Scotland	12	15	0
Ireland, f.o.q.	13	7	6
No. 3 BARS:			
England and Wales ..	11	5	0
Scotland	12	7	6
Ireland, f.o.q.	11	17	6
No. 4 BARS:			
England and Wales ..	11	15	0
Scotland	12	12	6
Ireland, f.o.q.	12	7	6
STRIP:			
England and Wales ..	14	2	6
STAFFS MARKED BARS, f.o.t...	15	15	0

NICKEL SILVER, &c.

	Per lb.
Ingots for raising ..	9d. to 1/3
Rolled—	
To 9 in. wide ..	1/3 to 1/9
To 12 in. wide ..	1/3½ to 1/9½
To 15 in. wide ..	1/3½ to 1/9½
To 18 in. wide ..	1/4 to 1/10
To 21 in. wide ..	1/4½ to 1/10½
To 25 in. wide ..	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.
December 21, 1939

	Dols.
No. 2 foundry, Phila.	24.84
No. 2 foundry, Valley	23.00
No. 2 foundry, Birm.	19.38
Basic, Valley	22.50
Malleable, Valley	23.00
Grey forge, Valley	22.50
Ferro-mang., seaboard	100.00
O.-h. rails, h'y, at mill ..	40.00
Billets	34.00
Sheet bars	34.00
Wire rods	2.00
	Cents
Iron bars, Chicago	2.15
Steel bars	2.15
Tank plates	2.10
Beams, etc.	2.10
Skelp, grooved steel	1.90
Steel strip	2.10
Sheets, galv., No. 24	3.50
Wire nails	2.55
Plain wire	2.60
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.00

COKE (at ovens)

Welsh foundry	38/-
,, furnace	27/6 to 28/6
Durham foundry	37/-
,, furnace	29/2
Scottish foundry ..	35/- to 37/6
,, furnace ..	29/- to 30/-

TINPLATES

f.o.b. Bristol Channel ports

I.C. cokes	20 × 14 per box		31/6 to 32/-
,,	28×20 ,,		63/- to 64/-
,,	20×10 ,,		44/3 to 44/6
,,	18¾×14 ,,	..	33/3
C.W.	20×14 ,,		31/- to 32/-
,,	28×20 ,,		62/- to 64/-
,,	20×10 ,,		43/- to 44/6
,,	18¾×14 ,,		32/- to 33/3